General InformationBody Repairs, General Body Repairs

Edition 04.2018

Repair Group

Technical information should always be available to the foremen and mechanics, because their careful and constant adherence to the instructions is essential to ensure vehicle road-worthiness and safety. In addition, the normal basic safety precautions for working on motor vehicles must, as a matter of course, be observed.

Contents

1 Safety precautions

(AKAH000011; Edition 04.2018)

1.1 Fuel tank and fuel pipes

Take extreme care when performing sanding and welding work near the tank or other components carrying fuel. If in doubt, always remove these components.

All relevant health and safety regulations must be complied with when working on vehicles with natural gas tank.

1.2 Air conditioning system / refrigerant

No welding, brazing or soldering may be performed on parts of the charged air conditioner system. This also applies to any other part of the vehicle if there is a risk that parts of the air conditioner system could heat up. When performing paintwork repairs, object temperatures of 80° C must not be exceeded in the drying oven or preliminary heating area, because heat causes a major pressure increase in the system which leads to a high-pressure safety valve on the air conditioner compressor being activated.

Note

The refrigerant must also be extracted from the circuit when arc-welding in the vicinity of the refrigerant hoses. Arc-welding emits invisible ultraviolet rays which can penetrate the refrigerant hoses and decompose the refrigerant.

1.2.1 Remedy:

Extract refrigerant from refrigerant circuit ⇒ Air conditioning system; Rep. gr. 87 ; Heating, air conditioning

1.3 Electronic control units

Connect the earth connection of the electric welding appliance directly to the part which you are welding. When doing this, make sure that there are no electrically insulating parts between the earth connection and the welding point.

Earth connection and welding electrode must NOT make contact with the electronic control units or the electrical wiring.

After an accident, the electronic control units only have to be renewed if at least one of the following conditions applies:

- The housing is visibly deformed or damaged.
- The contact surface or the mounting bracket is deformed (although no external damage to the control unit is apparent).
- The connector is damaged or has been corroded by moisture.
- Functional check or self-diagnosis of the control unit indicates the fault “Control unit defective”.

If electronic components (e.g. ABS control units) were removed in order to carry out repair work and have now been re-installed, they must be checked according to the documentation available; for example, V.A.G. self-diagnosis must be performed.

1.4 Battery, power supply

Note

Before disconnecting the battery, make sure that you have the radio code. Before returning the vehicle to the customer, enter the correct code so that the radio is ready for use.

Before starting welding work, always detach both battery clamps and cover battery terminals.

Always remove the vehicle battery before performing any work which may generate sparks in the vicinity of the battery.

WARNING

Before connecting the battery, refer to the notes for the specific vehicle in the Workshop Manual.

⇒ Electrical system; Rep. gr. 27 ; Battery; Disconnecting and connecting battery

1.5 High-voltage components / electric vehicles

DANGER!

Work on high-voltage components and electric vehicles may only be performed by specially trained staff.

For further information, refer to the Workshop Manual for the specific vehicles ⇒ Electrical system; Rep. gr. 00 ; Safety precautions .

1.6 Natural gas vehicles

DANGER!

Work on natural gas vehicles may only be performed by specially trained staff.

For further information, refer to the Workshop Manual for the specific vehicles ⇒ Power unit; Rep. gr. 00 ; Natural gas engines - General information; Safety precautions .

2 General notes on body repairs

The aim of the repair is always to restore the original joint.

The Workshop Manuals describe the standard repairs. They do not include any descriptions of more complex repair work, as such work involves detaching the damaged parts at the original joint. Where possible, the joining techniques described can be used provided that their suitability has been ensured beforehand.

All repair work involving special separating cuts and joining techniques which do not restore the original joint (as manufactured) is checked and approved by Technical Development using calculations, strength tests and crash tests.

2.1 Original joint

The term “original joint” refers to joints which were made during manufacture of the vehicle.

These joints must be restored when carrying out body repairs.

When doing this, ensure that no fewer than the standard number of spot welds are made when carrying out repairs.

Repair methods and procedures which do not restore the original joint are described in the relevant Body Repairs workshop manual.

2.2 Galvanised body parts

The use of fully galvanised panels ensures a high level of corrosion protection for the body shell. In order to maintain the warranty cover against rust perforation when performing repairs, it is essential to comply with the procedures described; refer to ⇒ page 56 .

WARNING

As the welding of galvanised sheet steel gives off toxic zinc oxide in the welding fumes, the workshop must have efficient ventilation and fume extraction, e.g. in the form of a welding fume extractor - V.A.G 1586 A- .

2.3 Removing remaining material

If the damaged body part has been roughly cut out by making the separating cuts shown in the relevant workshop manual (e.g. using body saw), most spot welds can be drilled out using the spot weld breaker.

We also recommend using a parallel grinder and an angle grinder to remove the weld joints which cannot be removed with the spot weld breaker.

2.4 New parts

New parts which are no longer accessible from inside once the repair has been completed (e.g. side members) should be provided with suitable corrosion protection before being welded in. It is advisable to mask off the welding flanges when doing so.

Please refer to the Paintwork manual for further information.

Check new replacement parts e.g. doors, bonnet and boot lid/ tailgate or wing panel for transportation damage before passing them on to the paintshop. This avoids a second painting operation which would become necessary if transportation or other damage was not noticed until a later stage.

2.5 Moulded foam inserts

These pre-moulded parts are fitted during body manufacture and subsequently increase their volume in the paint shop drying oven at temperatures above approx. 180 °C after priming.

Proceed as follows when using moulded foam inserts:

- Remove residue of foam material on vehicle.
- Restore paint coating (follow instructions in Paintwork manual).

2.5.1 Required preparations

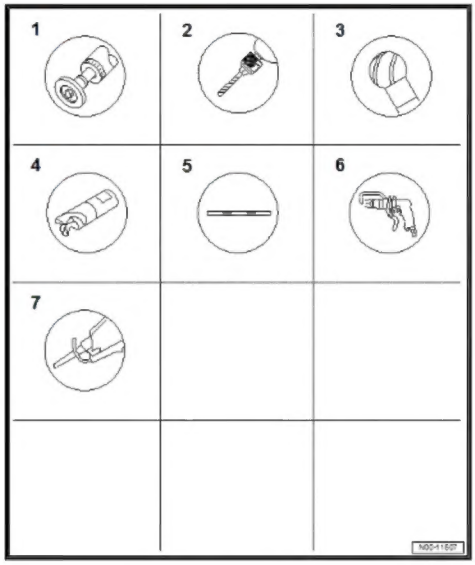
Before fitting a moulded foam insert, ensure that the replacement metal panel is ready for installation, i.e. cut to shape, matched up to the vehicle, corrosion protection applied.

2.5.2 Renewing moulded foam insert

- Apply butyl sealing cord or 2-component filler foam all around moulded foam insert.
- Fix moulded foam insert to vehicle.
- Secure new part (e.g. A-pillar) in position; press it in gently in area of moulded foam insert and then weld it in.
- Do not weld (SG) within 40 mm of foam insert (on either side).
- After painting the vehicle the repaired area must be cavity-sealed.

3 Explanation of symbols

3.1 Symbols relating to procedures for separating components



1 - Grinding components off/down

2 - Drilling

3 - Spherical cutter

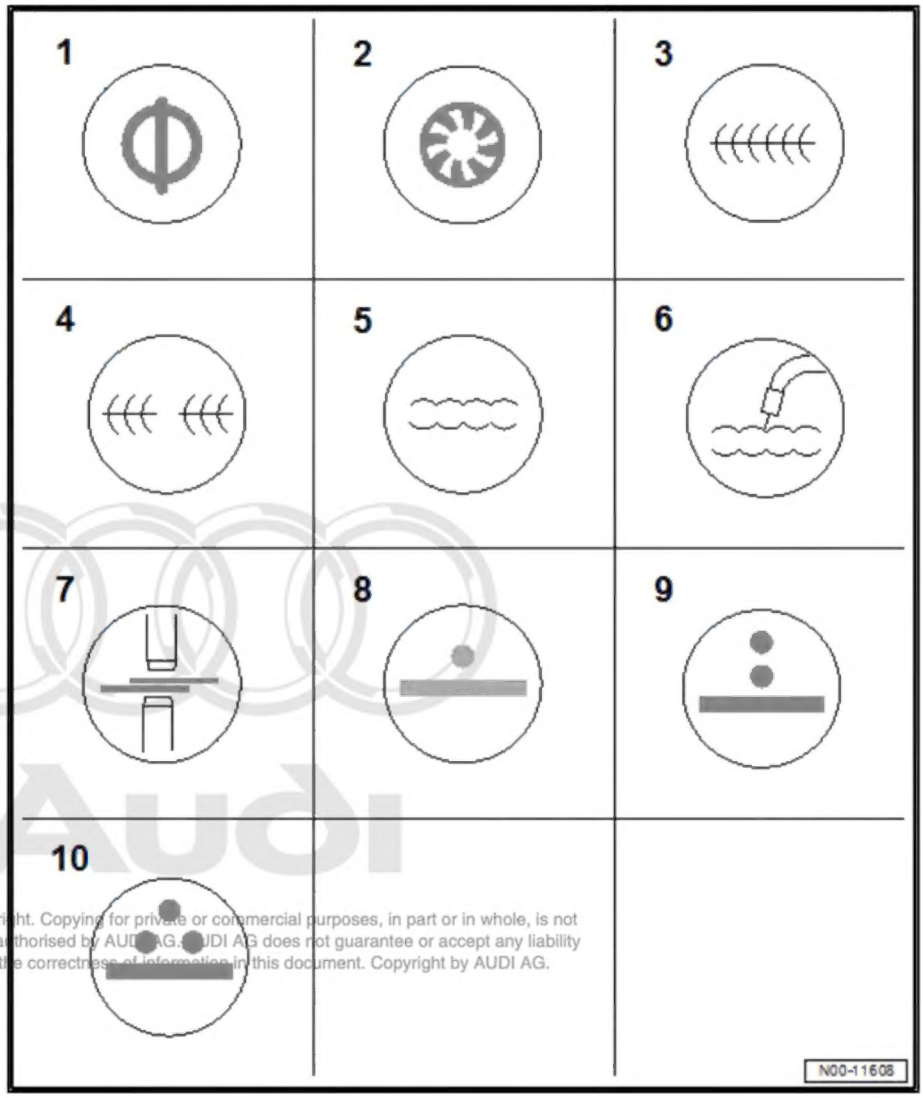
4 - BTR cutter

5 - Separating cut

6 - Opening up spot weld

7 - Saw-cutting

3.2 Symbols relating to welding, brazing and soldering



1 - Stitch weld

2 - SG plug weld

3 - SG continuous seam

4 - SG continuous seam (staggered - with gaps)

5 - Brazing

6 - MIG brazing

7 - Resistance spot welding (RP), general

8 - RP spot weld (single row)

9 - RP spot weld (double row)

10 - RP spot weld (double row, offset)

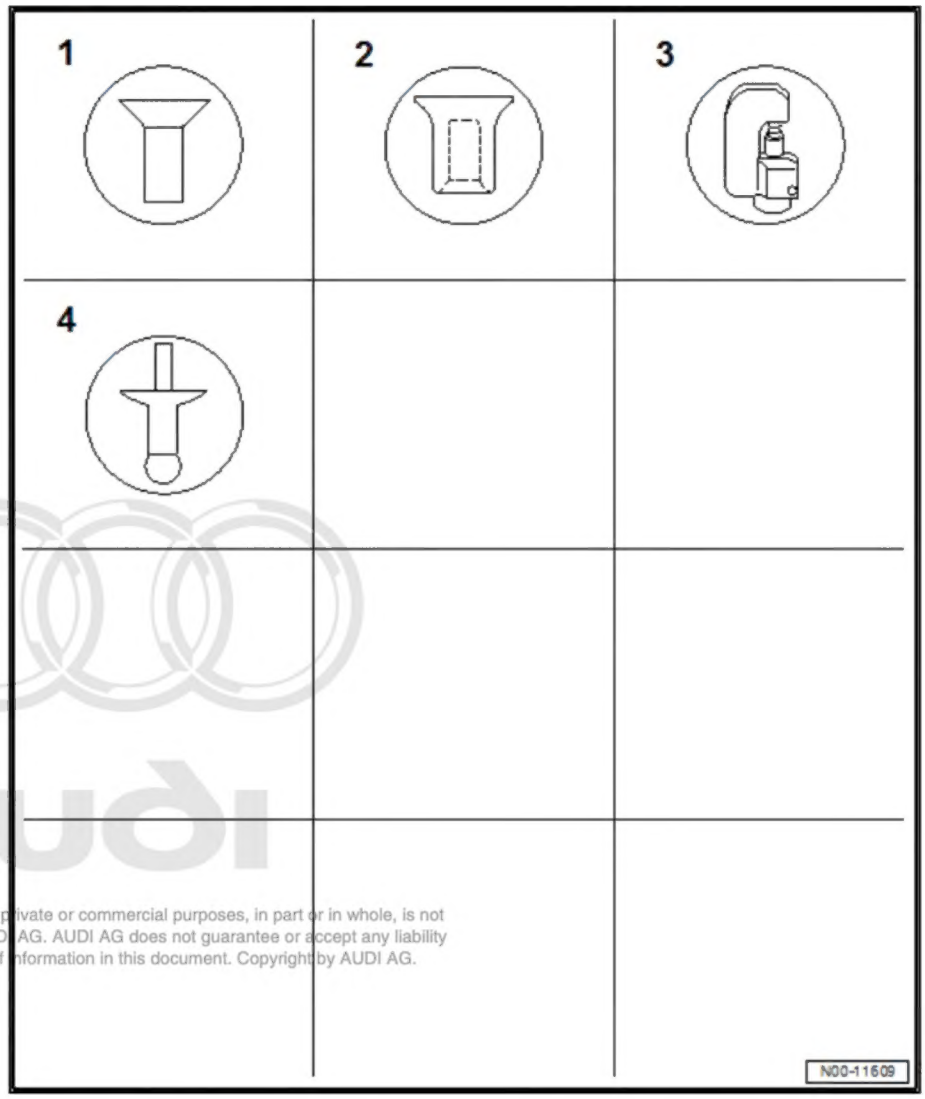
3.3 Symbols relating to rivets

1 - Solid rivet

2 - Self-piercing rivet

3 - Use a riveting tool

4 - Pop rivet



3.4 Symbols relating to preparation

1 - Fixing in position

2 - Joddling

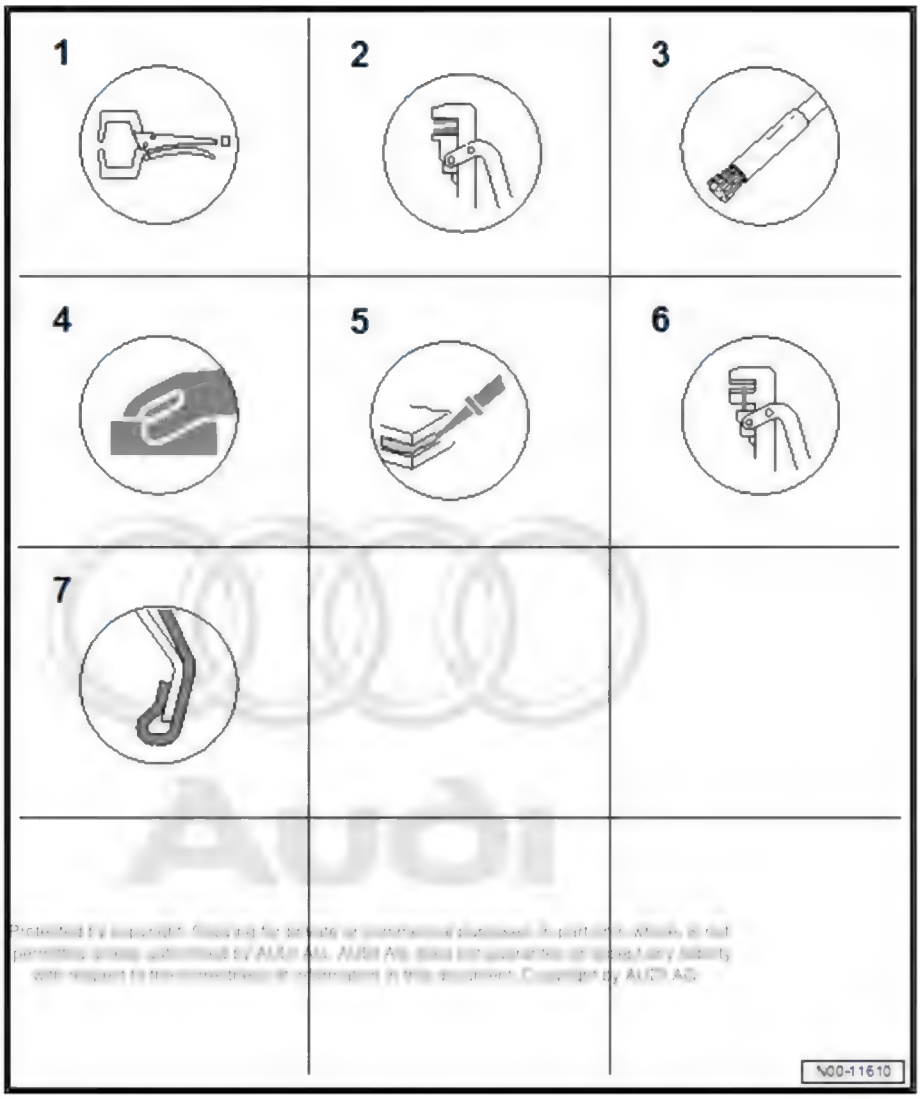
3 - Removing paint in locations which are difficult to access

4 - Smooth off by hand

5 - Apply adhesive

6 - Joddling

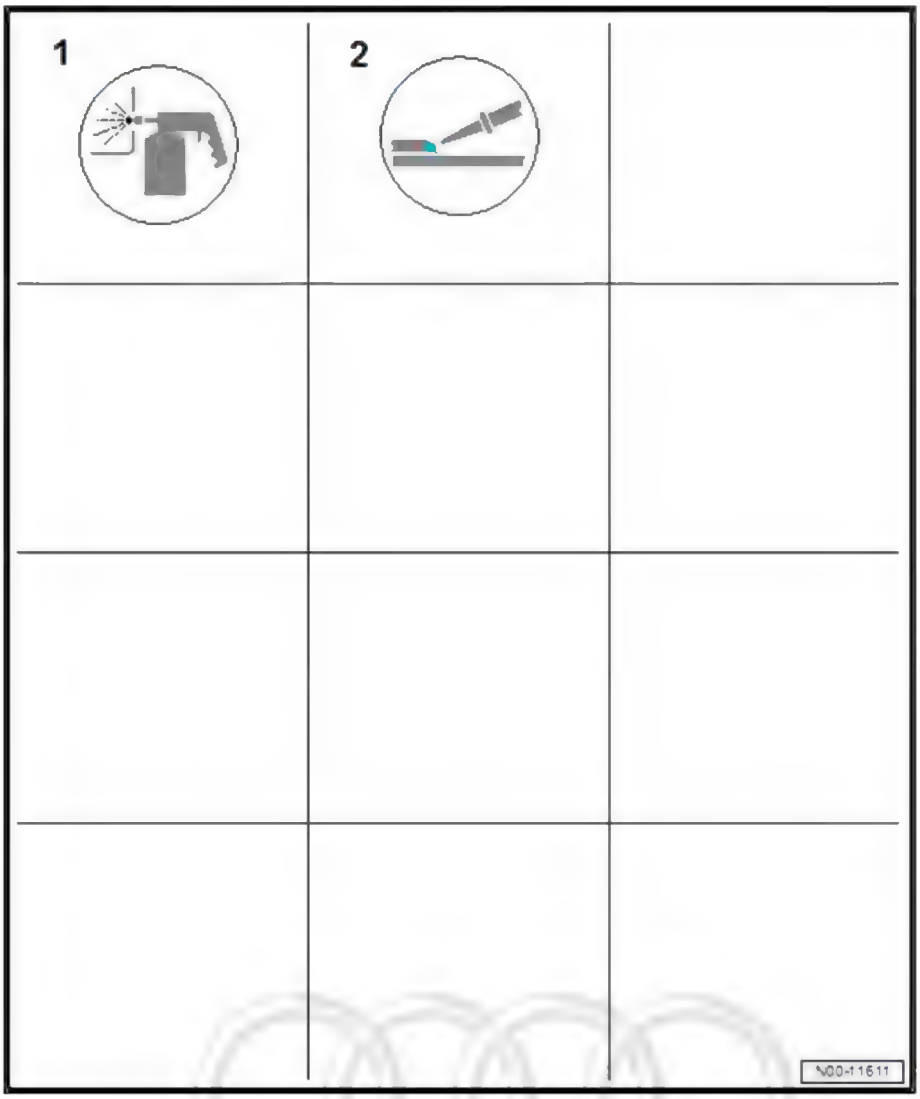
7 - Flanging



3.5 Symbols relating to corrosion protection

1 - Cavity sealing agent

2 - Sealing off



4 Vehicle body construction features

4.1 Multi-material mix

Vehicle bodies made of a combination of different materials are increasingly being used as an alternative to the classic all-steel body.

The materials most commonly used for the bodywork on today's vehicles are:

- Steel (various strengths)
- Aluminium
- Magnesium
- Plastics
- Fibre-reinforced plastics
- Carbon-fibre materials

4.2 Body structures

In addition to the well-known unitary body, there are also other body structures which are used for Volkswagen Group vehicles.

4.2.1 Aluminium space frame

The special feature of a space frame body is its supporting frame structure made of aluminium profiles which ensure the rigidity of the body. Although external body parts such as the roof or wing panels also play a role in the supporting structure, this is not their primary function (e.g. Audi R8).

4.2.2 Body-on-frame construction (e.g. VW Amarok)

Vehicles featuring a body-on-frame construction generally have a supporting ladder-frame structure which in turn supports the engine, chassis and body. This construction is primarily used on utility vehicles and off-road vehicles.

5 Assessing damage

5.1 General notes

When repairing vehicles which have been involved in an accident, damage to the running gear or engine/gearbox mountings, etc. is not always identified; in some cases this may result in serious damage later on. If the accident damage indicates a high impact load on the vehicle, special attention must be paid to the following components (in addition to the wheel alignment check, which must always be performed):

- Check to ensure that the steering assemblies and steering linkage operate correctly over the complete lock-to lock range. Carry out a visual check for bent or cracked parts.
- Check for distortion or cracking of running gear and all running gear components such as links, suspension strut, wheel bearing housing, anti-roll bar, subframe and axle beam, as well as associated fastening elements.
- Examine rims and tyres for damage, eccentricity and imbalance. Examine tyres for cuts/slits etc. in tread and sidewalls and check inflation pressure.
- Examine the engine/gearbox/axle/exhaust system mountings for damage.
- Finally, a thorough road test after completing repairs will give the assurance that the vehicle is completely roadworthy and ready for handing back to the customer.

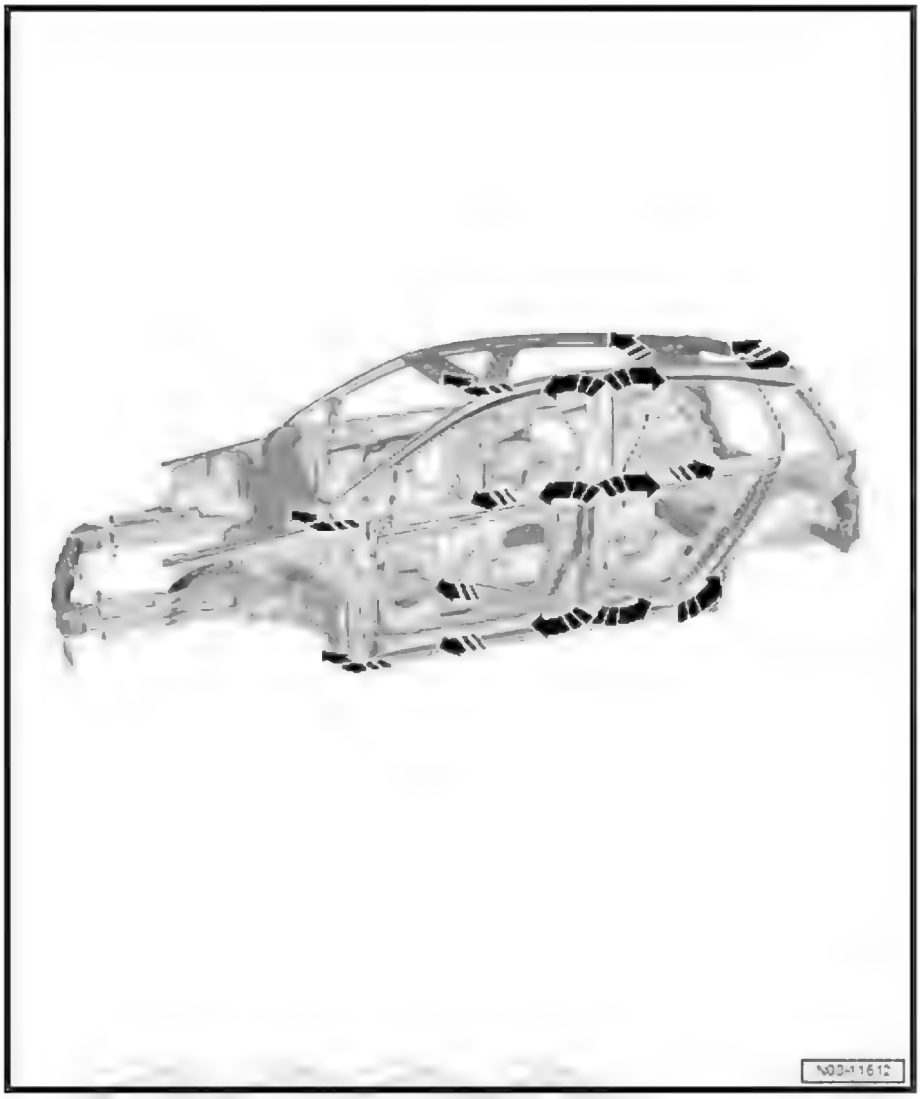
5.2 Checking weld seams and aluminium node castings

The dye penetration test is suitable for identifying surface cracks. The approved repair materials must be used.

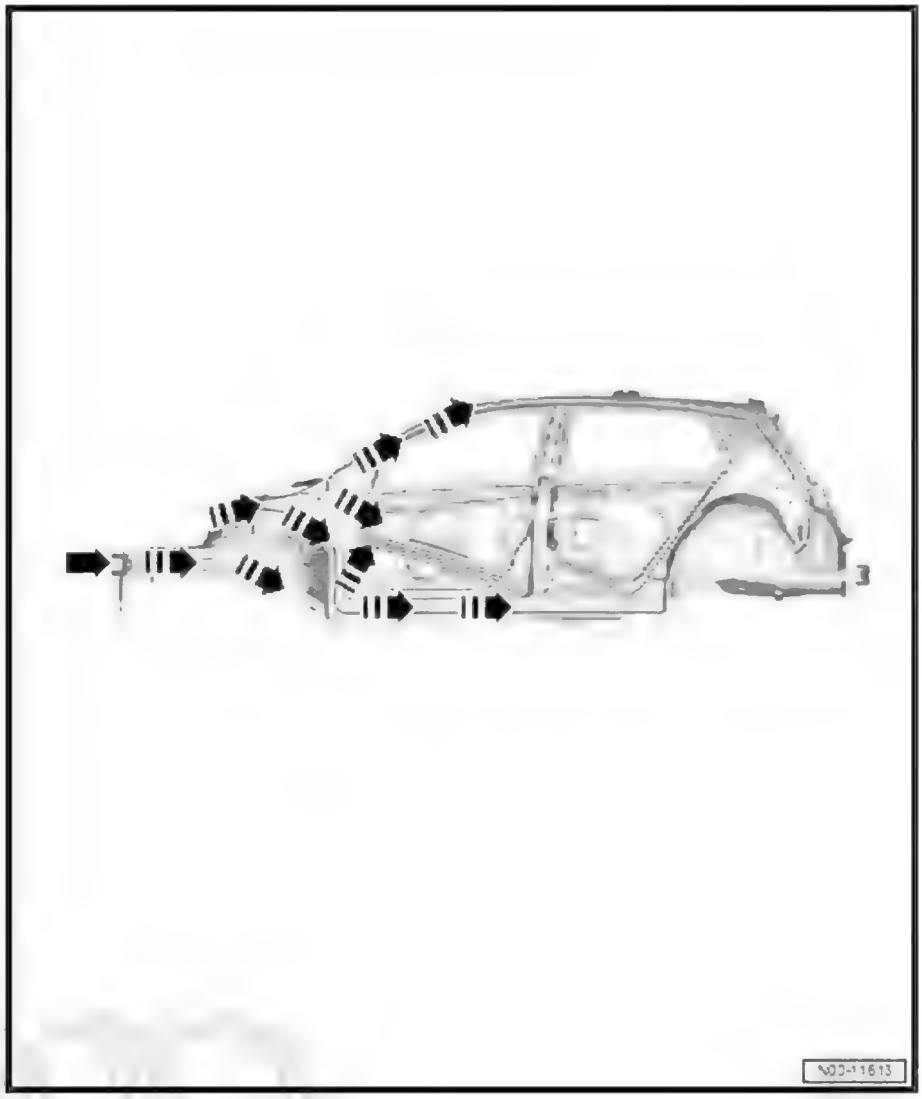
Note

Do not brush off the relevant area prior to testing, as this would fill in the cracks.

5.3 Load paths



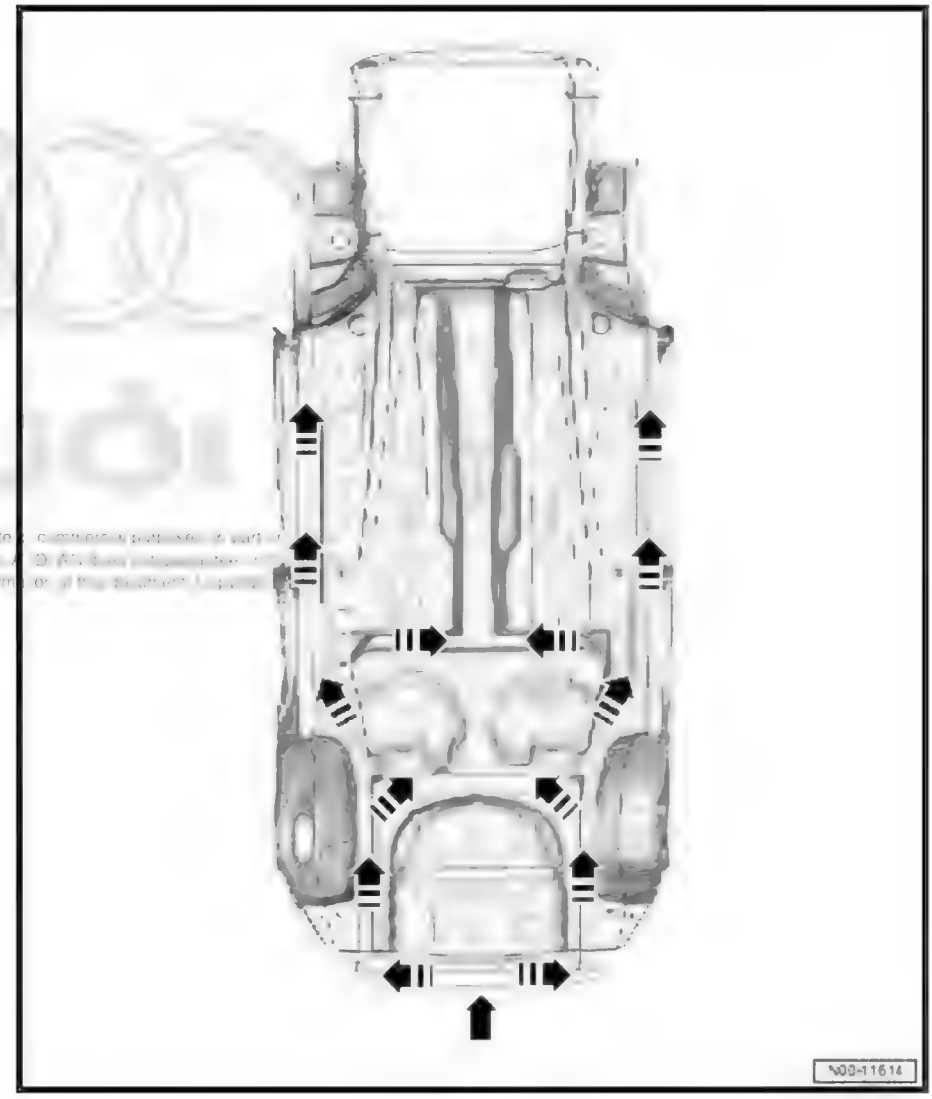
The illustration shows how the crash energy is distributed around the outside of the passenger compartment in the event of a side impact. When assessing damage, you should therefore pay particular attention to the side impact protection on the doors and the A-pillar and B-pillar joints with the side members and roof frame.



The objective of the body structure is to dissipate as much energy as possible in the front-end structure.

If the front-end structure has sustained significant damage, the transition area between the A-pillar and roof frame or side members must also be examined thoroughly when assessing the damage.

Due to the structure, the entire outer surface of the body should also be inspected, as elastic deformations in the high-strength structure may lead to structural deformations in the outer surface.



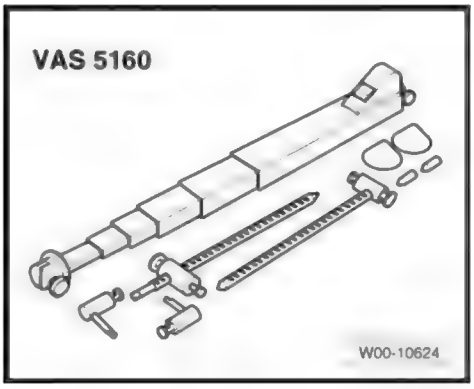
When assessing damage at the rear of the vehicle, you should pay particular attention to any warped metal in the area of the luggage compartment floor. Damage may occur here due to the cushioning effect of the materials used, even if the dimensions of the longitudinal members display no irregularities.

5.4 Measuring procedures / damage diagnosis

- Information on approved measuring devices can be found in the workshop equipment catalogue.
- Information on body dimensions and gap widths can be found in the Workshop Manual for the relevant vehicle.

⇒ Body Repairs; Rep. gr. Karosserie ; 00; Technical data

Telescopic gauge



Note

To diagnose accident damage quickly, it is often sufficient to perform a diagonal comparative measurement using a telescopic gauge.

5.5 Overview of materials used

5.5.1 Special properties of deep-drawn steel

In series production, the vehicle body and floor sections are primarily manufactured from cold-formed deep-drawn sheet metal panels. For this reason, the straightening of areas damaged in an accident should be carried out in the same manner. If the extent of the damage makes it impossible to straighten the part in this manner, the damaged part should not be cut out until the adjacent surfaces have been straightened.

5.5.2 Special properties of high-strength and ultra-high-strength steel

Extra-high-strength steel body panels are increasingly being used for Audi vehicles. For an overview of the areas in which these panels are used, refer to the illustration in the Body Repairs workshop manual ⇒ Rep. gr. 00 .

What are extra-high-strength steel panels?

They look the same as normal steel panels, but they have a higher yield point than standard steel body panels due to the different alloys which are used. In other words, when there is an equal impact on the panel, the dent in an extra-high-strength steel body panel will not be as deep as that in a standard steel body panel.

What has to be observed when removing dents?

Dents can be removed with the usual tools. Due to the greater buckling strength, there is more bounce, which means that more force may be necessary. Material may rupture when kinks are reformed.

What has to be observed when straightening panels using a straightening jig or hydraulic press?

Due to the greater bounce of extra-high-strength steel, it has be overstretched even more than standard steel to reach the desired position. However, the greater force applied also increases the stress placed on those parts made of standard steel which are welded to the extra-high-strength steel parts. Additional anchoring is required to prevent the standard steel yielding or rupturing.

WARNING

- *If extra-high-strength steel is overstretched, it will suddenly extend to a length greater than that required!*
- *For reasons of safety, it is not permitted to heat up extra-high-strength body steel when straightening it out (i.e. the same rule that applies to standard body steel).*
- *It is permissible to weld ultra-high-strength steel in accordance with the Workshop Manual using the specified separating cuts and welding methods.*

What are ultra-high-strength hot-formed steel panels?

As the name suggests, these are steel panels which have been hot-formed (at temperatures between 900 °C and 950 °C). A special cooling process in the forming die gives the steel panels their high-strength properties (hot stamping). Using ultra-high-strength hot-formed steel panels makes it possible to reduce the vehicle body weight without a loss of body strength. On vehicles with ultra-high-strength hot-formed steel, spot welding equipment with inverter must be used (refer to catalogue for workshop equipment and special tools).

Yield strength of sheet steel used:

Designation	Yield strength
Standard sheet steel	< 160 MPa (N/mm²)
High-strength sheet steel	< 220 MPa (N/mm²)
Extra-high-strength sheet steel	< 420 MPa (N/mm²)
Ultra-high-strength sheet steel	< 1000 MPa (N/mm²)
Ultra-high-strength hot-formed sheet steel	< 1000 MPa (N/mm²)

5.5.3 Special properties of aluminium

Aluminium is primarily used for the body structure of today's vehicles with a view to reducing weight and increasing rigidity.

In vehicle manufacture, there are the following different types:

- Aluminium sheet panels
- Aluminium extrusions (must not be bent back into shape)
- Aluminium castings (must not be bent back into shape)

The properties of these components differ fundamentally from each other. It is therefore essential to refer to the Workshop Manual for the relevant vehicle in the event of damage.

Note

- *The instructions below only apply to conventional vehicles with a steel body structure on which aluminium panels are fitted.*
- *For an overview of the areas in which these panels are used, refer to the illustration in the relevant Body Repairs workshop manual ⇒ Rep. gr. 00 .*

WARNING

Use separate tools for steel and aluminium.

It is recommended to have a special aluminium tool kit in the workshop trolley.

5.5.4 Contact corrosion

Contact corrosion can occur if unsuitable fasteners (bolts, nuts, washers etc.) are used. For this reason, only fasteners with a special surface coating are fitted. In addition, all rubber parts, plastic parts and adhesives are made of non-conductive materials. Always renew parts if you are in any doubt as to whether the old part can be used again.

Note

- *Always use genuine replacement parts (same as original equipment). These have been tested and are aluminium-compatible.*
- *Accessories must be approved by Volkswagen AG.*
- *If non-approved materials are used, any damage caused by contact corrosion is not covered by warranty.*

5.5.5 Special features of carbon fibre-reinforced plastics (CFRP)

Note

Only trained personnel are permitted to carry out work on CFRP components.

Safety measures

Adequate protective equipment must be used when working on CFRP components.

An extraction system MUST be used. Raising the parameters to speed up work can represent a health risk if this leads to vapours, smoke or dust being produced.

The following personal protective equipment must be used:

1 - Protective gloves

2 - Safety goggles

3 - Protective clothing

4 - Protective mask

Note

- *Only trained personnel are permitted to carry out work on CFRP components.*
- *Drilling, sawing, grinding and cutting work or any other forms of machining must not be performed on CFRP components.*
- *CFRP is electrically conductive. However, it is not permissible to create an electrical earth connection via CFRP.*
- *When working with electrical wires, all contact with CFRP components must be avoided (danger of short circuit).*
- *When performing repair work on vehicles and when removing and installing components such as power units, it is essential to avoid all major contact with CFRP components (danger of irreparable and non-visible damage to CFRP structure).*
- *When performing work on the vehicle body, it is only permitted to use materials (e.g. primer, adhesive, rivets) approved by the manufacturer.*
- *When performing work on the vehicle body, it is only permitted to use procedures approved by the manufacturer.*

Properties of CFRP:

CFRP is the abbreviation for carbon fibre-reinforced plastics (or carbon fibre-reinforced polymers).

Diameter of fibres = approx. 6µm

Specific weight = 1.8g/cm³

Tensile strength = 3530-4560 MPa

Elongation = 1.1-1.5 %

Between 1,000 and 24,000 individual fibres are twisted together to form bundles which are weaved together.

Advantages of CFRP components

- Extremely low weight: approx. 60% lighter than steel, approx. 30% lighter than aluminium
- Outstanding stability: approx. 4 times more resilient than aluminium
- 100% corrosion-proof
- Gas-tight and pressure-sealed
- High long-term thermal stability
- Barely measurable thermal expansion

Disadvantages of CFRP components

- Very expensive materials

- Difficult to assess materials after an accident. Possible damage (e.g. cracks) which is not visible to the human eye may make it necessary to use thermal imaging, infrared and X-ray methods.
- It is generally not permitted to repair structural CFRP components; these components must be renewed.

Important notes relating to the use of CFRP in series-production vehicles:

For use in vehicles, its characteristics must be especially taken into account with a view to more widespread servicing and repairs in workshops. CFRP components are far less tolerant to damage than metals. If a component is delaminated, it must be renewed. Only apply the absolute minimum amount of force required in order to avoid damaging components remaining on the vehicle. Use the specified tools only. Pay very careful attention to the described procedure and parameters; these will help to ensure that you can work without causing any additional damage. It is very important to perform this work very carefully and patiently.

CFRP components are all different

Unlike metals, the properties of CFRP are specific to individual components and cannot be generalised. Each component has its own individual characteristics, depending on the resin and fibres used, the fibre orientation, the manufacturing method and many other factors.

Deformation properties

CFRP components can be designed to dissipate energy by falling apart, or to protect the safety cell in the event of an impact. Equally, they can also be designed to deform. It is therefore important to treat every component on its own merits and to follow the appropriate instructions.

Springback after load is applied

When load is applied, a CFRP component can deform, break or suffer internal damage. After the load has been relieved, springback is possible for the component. In such cases, proper assessment of the component is critical to determine whether there is any internal damage.

Detection of damage

Cracks, scratches and fibre breakage can be assessed from the outside. If the back of the component is visible, it is possible to detect impact damage in some cases. Any delamination caused by an impact reduces the component's strength (including its flexural strength) and therefore the laminate's strength and buckling resistance. As a visual inspection alone is not sufficient to assess damage to CFRP components and as the characteristics of the components are impaired dramatically by minor damage, it is extremely important to carry out an inspection without causing any irreparable damage before damage diagnosis is performed.

Overview of test methods which do not cause irreparable damage

- Radiographic method = computer tomography (CT)
- Acoustic method = ultrasound, knock test
- Optical method = shearography
- Thermal method = thermography
- Electric/magnetic method = eddy-current testing

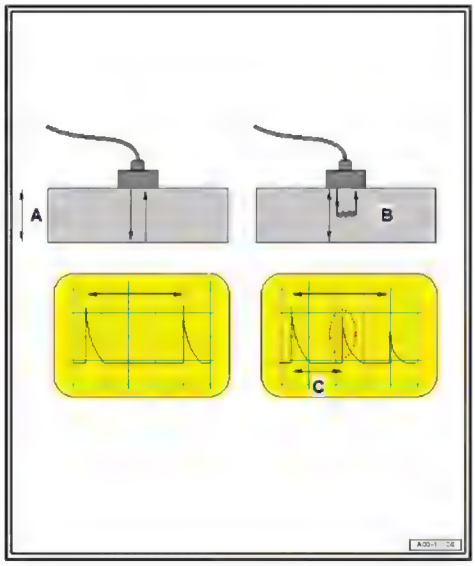
AUDI AG uses the ultrasound method for diagnosis of CFRP components.

The test unit transmits very short ultrasonic pulses (1...10µs). The sound passes through the component being tested and reflects off the back panel; the echo is reflected back to the test unit. The data are compared with those of a fault-free component.

A - Material thickness

B - Fault in component

C - Fault depth



5.5.6 Special features of plastics in general

Plastics are used in a very wide range of areas. For information on their properties and repair notes, refer to the repair notes for the relevant vehicle or to the chapter “Plastic repairs” (⇒ page 58).

5.6 Passive safety

5.6.1 Restraint systems (seat belt systems)

> **WARNING**
>
> *After an accident, the seat belt system must always be checked systematically. If any damage is determined the customer must be informed that the belt has to be renewed.*

Points to check:

- Check belt ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Checking belt .
- Check automatic belt retractor (locking action) ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Checking automatic belt retractor (locking action) .
- Perform visual inspection of belt buckle ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Visual inspection of belt buckle .
- Perform functional check of belt buckle ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Functional check of belt buckle .
- Check guide fittings and latch plate ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Checking guide fittings and latch plate .
- Check securing components and anchorage points ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Checking securing components and anchorage points following an accident .

Note

If customers decide not to have damaged seat belts renewed, this must be noted accordingly.

5.6.2 Safety regulations for belt tensioners

- Tests, repairs and service work may only be performed by suitably trained staff.
- The pyrotechnic mechanism has no expiry date and is maintenance-free.
- Belt tensioner components must not be opened or repaired; always use new parts.
- Belt tensioner units which have been dropped to the ground must not be installed.
- Belt tensioner units with mechanical damage (dents, fractures) must always be renewed.
- Belt tensioner units should be installed immediately after removing them from their packaging.
- If work is interrupted, belt tensioner units should be put back in their packaging.
- Belt tensioner units must not be left unattended.
- Belt tensioner units must not be treated with grease, cleaning agents or similar substances, and must not be exposed to temperatures above 100 °C, even for short periods.

5.6.3 Working on vehicles with belt tensioners

WARNING

Belt tensioners which are triggered mechanically and do not have a belt-fastened sensor (triggering lock) must be removed before beginning any cutting, straightening and/or dent removal work. In the case of belt tensioners which are triggered electrically the battery earth strap must be disconnected.

Note

When the belt is fully retracted, the belt-fastened sensor (triggering lock) will prevent the belt tensioner (mechanical triggering) from being activated in an accident.

WARNING

In the case of belt tensioners with belt-fastened sensor, the belt must NOT be pulled out during cutting, straightening and/or dent removal work. Before performing any cutting, straightening and/or dent removal work involving severe vibration, belt tensioners with belt-fastened sensor must also be removed.

For further information, refer to the Workshop Manual for the relevant vehicle ⇒ General body repairs, interior; Rep. gr. 69 ; Passenger protection; Seat belts .

5.6.4 Disposal of non-triggered pyrotechnic components

- Airbags,
- seat belts,
- pyrotechnic battery isolation elements,
- and the triggering unit for the active front lid/bonnet

must be disposed of in their original packaging and in accordance with national regulations. Please contact your regional office or your Importer if you have any questions.

Note

Pyrotechnic components ignited in an accident can be disposed of together with commercial refuse.

WARNING

This does not apply to Wankel-type belt tensioners.

These must be treated in the same way as pyrotechnic components which have not been triggered, as it is not possible to use workshop equipment to check whether all stages have been triggered.

5.6.5 Restraint systems (airbag systems)

Always refer to the Workshop Manual for the relevant vehicle when working on airbag systems. Refer to ⇒ General body repairs, interior; Rep. gr. 69 ; Airbag system; Overview of fitting locations - airbag system , as well as the corresponding safety precautions ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Safety precautions when working on pyrotechnic components .

WARNING

- *The battery earth strap must be disconnected when working on the airbag system and when performing straightening work during body repairs.*
- *Switch on ignition before connecting battery.*
- *There must be nobody in the vehicle when connecting the battery!*
- *Airbag components must not be subjected to temperatures above 100 °C, even for a very brief period.*
- *Airbag components must not come into contact with grease, cleaning agents, oil or similar.*
- *Airbag components with mechanical damage must be renewed.*
- *Wash hands after touching airbag units which have been triggered.*

5.6.6 Particular points to note when working on seats with side airbag

WARNING

It is essential to observe the safety precautions when removing seats.

Refer to the Workshop Manual for the relevant vehicle for information on safety precautions ⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Additional safety regulations for side airbags .

5.6.7 Notes on disposal

⇒ General body repairs, interior; Rep. gr. 00 ; Safety precautions; Storing, transporting and disposing of airbag units, belt tensioner units and battery isolation units (pyrotechnic components)

6 Thermal joining techniques

This chapter provides details about the thermal joining processes currently used in body welding work.

6.1 Resistance spot welding (RP)

When performing welding repairs, the original joint should always be restored wherever possible.

To do so, the following requirements must be fulfilled:

- The panels which are to be welded must overlap.
- The welding point must be accessible on both sides for the electrodes.
- The resistance spot welder must have sufficient power to make spot welds of the original diameter.

For body repair work, access to the welding points may vary, a full set of the electrode versions most commonly used must be available for each resistance spot welder.

RP welding of galvanised panels

Note the following points when resistance spot welding galvanised panels:

- The flanges to be welded must make contact. If necessary, clamp the flanges together.
- This is particularly important on high-strength steel panels, as the electrode force will otherwise not be sufficient.
- Make sure you do not make spot welds with welding tongs directly next to the clamps, as this would allow a large proportion of the welding current to drain off in a shunt circuit.
- If the distance between the spot welds is small, place spot welds in a row or secure by initially welding every third spot and then fill in the remaining spots. This helps to reduce the effect of a shunt current.
- Please observe the operating instructions and the information on correct settings provided by the manufacturer of the welding equipment.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

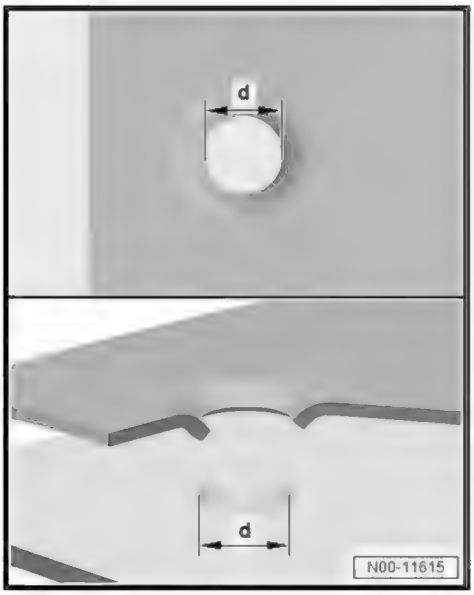
Spot weld peel test

- To determine the required weld nugget diameter, establish the setting parameters specified by the manufacturer and carry out test using samples.
- Check all spot welds 100% by performing a chisel test.

High-quality spot welds peel off in the weld contact area; they do not shear off.

- Calculate the weld nugget diameter according to the following formula ("peel diameter") and carry out test on samples before starting repair work.

  Square root of T1 x 3.5 x 1.15



Note

T1 is the thinner panel of a pair of panels (e.g. pair of panels with 1.5 mm and 0.8 mm). Example: Square root of 0.8 x 3.5 x 1.15 = 3.6 mm weld nugget diameter. The narrow, welded test strip is rolled or torn off the second sheet metal strip with a force applied vertically to the surface of the metal.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

WARNING

- *Always use an extraction system when performing welding and grinding work.*
- *Welding and grinding must never be performed simultaneously in the same working area.*
- *Working area must be cleaned at regular intervals as necessary to remove dust.*
- *Compressed air must NOT be used to blow out dust deposits.*
- *The extraction system must be cleaned at regular intervals.*
- *In addition, the relevant accident prevention and industrial safety regulations must be observed.*

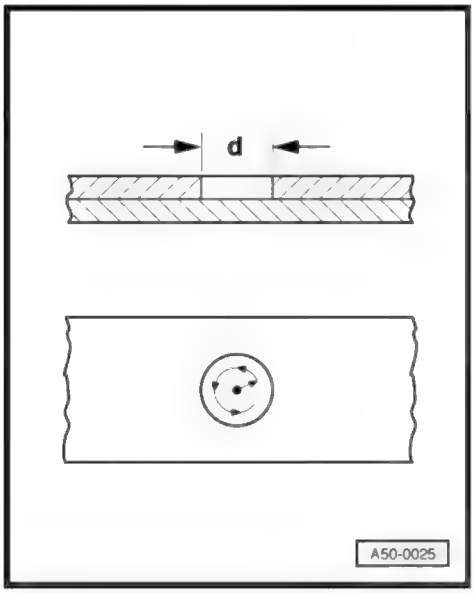
6.2 Shielded arc plug welding (SG plug welding)

SG plug welds are primarily used where spot welds used as standard cannot be restored for reasons such as limited accessibility.

It is essential to refer to the Workshop Manual for the relevant vehicle in such cases.

Basic procedure for SG plug welds

- Remove spot welds with a spot weld cutter or grind them down.
- Detach damaged part (use a chisel if necessary).
- Grind down projecting material.
- Match up new part.
- Drill hole for plug weld in upper panel (for diameter, refer to Workshop Manual for relevant vehicle).
- Clean flanges and remove oxide layer.
- Make plug weld, working outwards from centre.



Note

Riveting is also permissible in some cases. Refer to "Body Repairs" workshop manual.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

WARNING

- *Always use an extraction system when performing welding and grinding work.*
- *Welding and grinding must never be performed simultaneously in the same working area.*
- *Working area must be cleaned at regular intervals as necessary to remove dust.*
- *Compressed air must NOT be used to blow out dust deposits.*
- *The extraction system must be cleaned at regular intervals.*
- *In addition, the relevant accident prevention and industrial safety regulations must be observed.*

6.3 SG continuous seams and stitch weld seams

SG continuous seams and stitch weld seams are primarily used for joining parallel or overlapping surfaces. Due to the very high welding temperatures and the associated change in the properties of modern materials, the areas in which this joining technique are used are becoming increasingly restricted. It is essential to refer to the Workshop Manual for the relevant vehicle in such cases.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

WARNING

- *Always use an extraction system when performing welding and grinding work.*
- *Welding and grinding must never be performed simultaneously in the same working area.*
- *Working area must be cleaned at regular intervals as necessary to remove dust.*
- *Compressed air must NOT be used to blow out dust deposits.*
- *The extraction system must be cleaned at regular intervals.*
- *In addition, the relevant accident prevention and industrial safety regulations must be observed.*

6.4 MIG soldering/brazing

MIG soldering/brazing differs essentially from SG stitch welding or continuous welding in terms of the significantly lower temperatures required. The advantage of MIG soldering/brazing is the significantly reduced amount of material distortion in the components which are being joined. This technique is therefore also suitable for joining larger flat components.

Further advantages are:

- Fewer changes to the structure of the components
- Less damage to the corrosion protection provided as standard
- Zinc layer on components remains intact

What is MIG soldering/brazing? (not approved for AUDI AG vehicles)

- It is a soldering/brazing technique also known as gas metal arc welding.
- The basic material (vehicle body panels) is not fused together; the brazing solder coats the edges and joins the components.
- MIG stands for metal inert gas. The inert gases are not involved actively in the processes between the arc and the filler material.
- The shielding gases used include argon or helium, mixed with carbon dioxide or oxygen.
- Up to 450 °C: soldering
- Above 450 °C: brazing

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

WARNING

- *Always use an extraction system when performing welding and grinding work.*
- *Welding and grinding must never be performed simultaneously in the same working area.*
- *Working area must be cleaned at regular intervals as necessary to remove dust.*
- *Compressed air must NOT be used to blow out dust deposits.*
- *The extraction system must be cleaned at regular intervals.*
- *In addition, the relevant accident prevention and industrial safety regulations must be observed.*

6.5 Aluminium welding

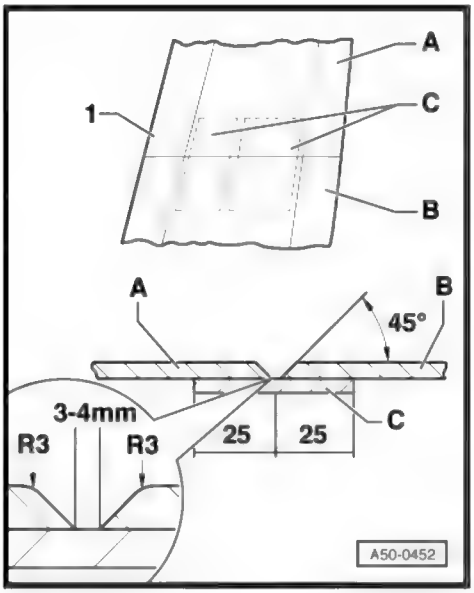
Inert gas welding (MIG) is a technique used both at the factory and in the workshop.

The shielding gas used is argon.

- Remove underseal and paint from components prior to welding.
- Then use a stainless steel brush to remove oxide layer (approx. 40 mm on both sides).
- Weld seams must always be continued around section corners to prevent crack formation.

Note

- *Use - 4D0 898 103- sheet metal for practice welding and repairs.*
- *Refer to the training documentation on aluminium welding for further details.*



Placing backing plate of same material behind joint

Backing plate of same material -C- is made from remnants of new part -B- or old part -A-. Also place backing plate of same material behind joint at beaded panel edges. The material is cut for small cross-sections or large panel edges.

– Bevel both panels to an angle of 45°. Round off outer edge (radius = R3) and chamfer inner edge.

There must be a gap of 3 to 4 mm between panel tips.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

WARNING

- *Always use an extraction system when performing welding and grinding work.*
- *Welding and grinding must never be performed simultaneously in the same working area.*
- *Working area must be cleaned at regular intervals as necessary to remove dust.*
- *Compressed air must NOT be used to blow out dust deposits.*
- *The extraction system must be cleaned at regular intervals.*
- *In addition, the relevant accident prevention and industrial safety regulations must be observed.*

6.6 Laser welding

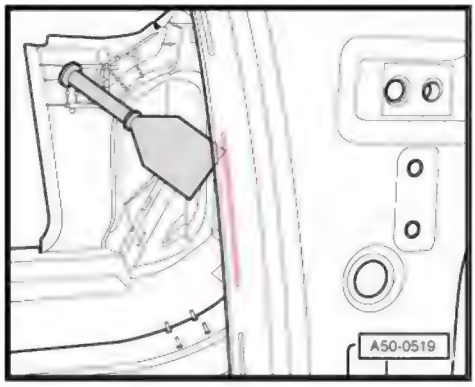
Note

This joining technique is only used during the manufacture of the vehicle.

For information on the relevant renewal procedure, refer to the corresponding chapter (⇒ page 29 or ⇒ page 30).

It is essential to refer to the Workshop Manual for the relevant vehicle in such cases.

The laser welding technique employs a high-energy light beam directed onto the weld seam by means of optical lenses or fibre optics. During the welding process the upper panel is fused onto the partially molten lower panel, creating a welded joint both with and without additional material.



6.7 Laser soldering/brazing

Note

This joining technique is only used during the manufacture of the vehicle.

For information on the relevant renewal procedure, refer to the corresponding chapter (⇒ page 29 or ⇒ page 30).

It is essential to refer to the Workshop Manual for the relevant vehicle in such cases.

A filler material is always used when performing laser soldering/ brazing. In most respects, the soldered/brazed joint is no different from an MIG brazed joint.

The only difference is that the filler material is melted on using a concentrated light beam (similarly to laser welding), rather than an arc. This laser technique enables the energy to be used precisely where it is needed. Unwanted side effects such as thermal distortion are negligible.

6.8 Replacement joining techniques in repair work (steel)

In production	For repair measures
Spot welding	Spot-weld bonding / MAG plug-welding / MAG welding
MAG welding	MAG welding
MIG soldering/brazing	MAG welding
Laser welding	MAG welding
Laser soldering/ brazing	MIG soldering/brazing (not approved for AUDI AG vehicles) Bonding MAG welding Note information in Workshop Manual
Bonding	Bonding / MAG welding
Spot-weld bonding	Bonding with spot welding / additional weld spots / additional MAG welding
Pop riveting	Pop rivets Only use pop rivets specified in Workshop Manual. As a rule, commercially available pop rivets do not provide sufficient strength.

6.9 Replacement joining techniques in repair work (aluminium)

In production	For repair measures
MIG welding	MIG welding
Spot welding	Not used
MIG soldering/brazing	Not used
Laser welding	Bonding and riveting
Bonding	Bonding and riveting
Punch riveting	Punch riveting
Pop riveting	Pop rivets Only use pop rivets specified in Workshop Manual. As a rule, commercially available pop rivets do not provide sufficient strength.

7 Cold joining techniques

7.1 Bonding

Adhesive-bonded joints and spot-welded bonded joints are being used increasingly at the factory, as they help to improve body rigidity and strength.

They are distinguished as follows:

- In the case of adhesive-bonded joints, the joint between the sheet metal parts is formed only by the adhesive.
- Adhesive-bonded joints with additional spot welds or rivets are known as hybrid joints.

Note

The bonded joints may only be restored using the materials listed in the Workshop Manual or parts catalogue.

7.1.1 Making adhesive-bonded joints (aluminium)

Note

The descriptions below do not replace the Workshop Manual for the relevant vehicle.

Pre-treatment of old flange

- Remove remnants of adhesive, paint, wax, etc.
- Sand bonding surface down to bare metal using a clean sanding disk (grain size 80 or 100).
- Treat flanges with silicate sanding stone.

A silicate adhesive layer is formed which ensures long-term durability of the bonded joint. The surface becomes matt.

- Remove sanding dust with a clean brush (do not use any solvent).
- Use brush to apply thin coat of aluminium primer and allow to flash off.

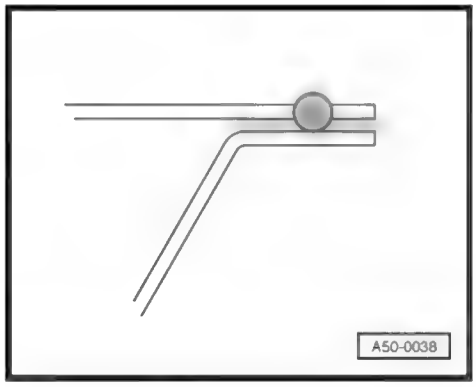
Pre-treatment of flange (on new part):

- Clean painted flange with special cleaner.

WARNING

Mask bonding surfaces when painting inside of new parts.

- Apply adhesive to body side, join parts and secure in position. Diameter of adhesive bead: 3.5 mm



Parts must be joined and secured in position within processing time specified by manufacturer of adhesive; otherwise a surface skin will form, resulting in inadequate adhesion at the flanges.

- Fit rivets and wipe off emerging adhesive.

Rivets must be fitted before adhesive has set. The time available depends on the ambient temperature.

It is essential to pay attention to the information on the technical data sheet for the adhesive.

Note

If adhesive comes out on both sides over the full length of the joint, this indicates that sufficient adhesive has been applied.

Adhesive must have hardened before further surface work is performed.

Note

- *For large parts, e.g. roof, the assistance of a second person is required, as otherwise adhesive will dry before work is completed.*
- *Ensure the openings of the double cartridge are clean before fitting the mixing nozzle. With mixing nozzle firmly in position, press out an approx. 10 cm long bead and apply adhesive.*
- *In the event of interruptions lasting up to 30 minutes, press out and discard an approx. 10 cm long bead to ensure that new material is properly mixed. In the event of interruptions lasting longer than 30 minutes, replace mixing nozzle and press out a 10 cm long bead. If several cartridges are required for repair work, the same mixing nozzle can be used.*

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

Note

- *Wear protective gloves and safety goggles.*
- *Ensure that adhesives do not make direct contact with skin.*
- *Avoid breathing in solvent vapours.*
- *Only work on adhesives in well ventilated areas.*
- *It is essential to pay attention to warnings provided by manufacturers.*
- *Also observe all safety regulations which apply in your country.*
- *The corresponding safety data sheets for the adhesives must be observed.*

7.2 Rivets

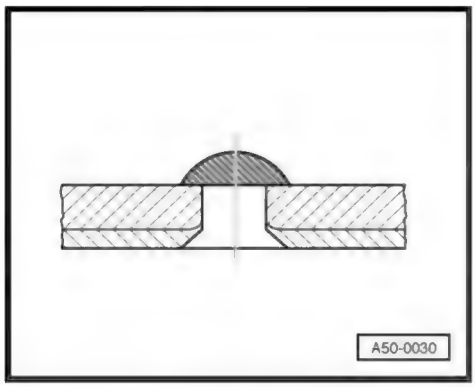
Note

For information on the special tools, testers, measuring devices and other equipment required, please refer to the Workshop Manual for the relevant vehicle or the workshop equipment catalogue.

7.2.1 Solid rivet

Opening solid rivets

- Start by making separating cuts where necessary.
- Grind off closing head and use riveting tool to press out solid rivet.
- Detach damaged part (use a chisel if necessary).



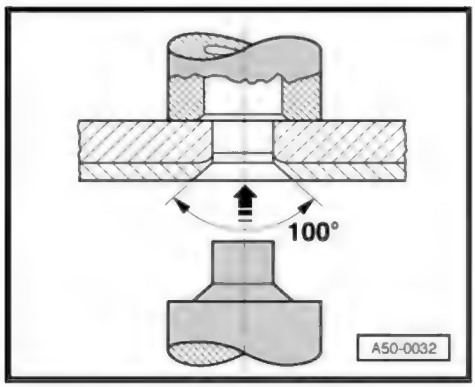
Fitting solid rivets

- Match up new parts, apply adhesive, position new part on body and secure in place.
- Use riveting tool to punch flanges.

Piercing and stamping are performed in one operation.

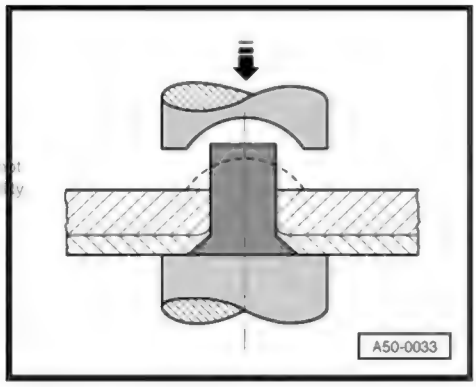
Note

Set riveting tool to material thickness for all operations. Insert suitable clamping pins in punched holes to stop flanges coming apart after punching.



- Insert solid rivet and use riveting tool to set closing head.

Appropriate inserts for the riveting tool are available for the various rivet diameters.



Note

- *All riveted joints have to be bonded when performing repairs in the workshop (unlike in series production). Refer to section on bonded joints ⇒ page 31 . The solid rivet is made of aluminium.*
- *Various solid rivets are available; refer to the Workshop Manual for the relevant vehicle.*

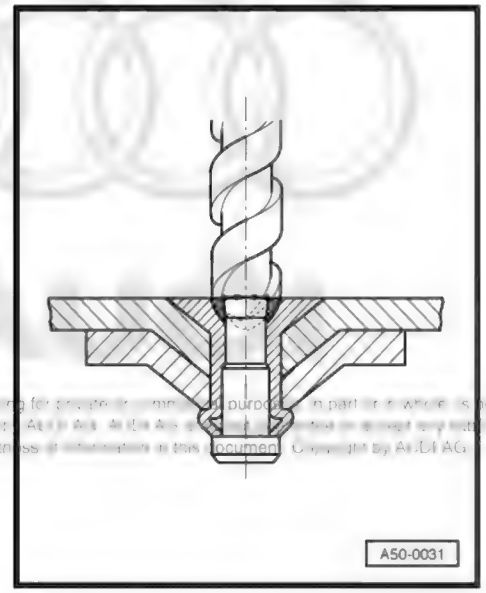
7.2.2 Pop rivet

Opening pop rivets

- Start by making separating cuts where necessary.
- Drill off pop rivet (drill bit diameter 4.5 mm).
- Detach damaged part (use a chisel if necessary).

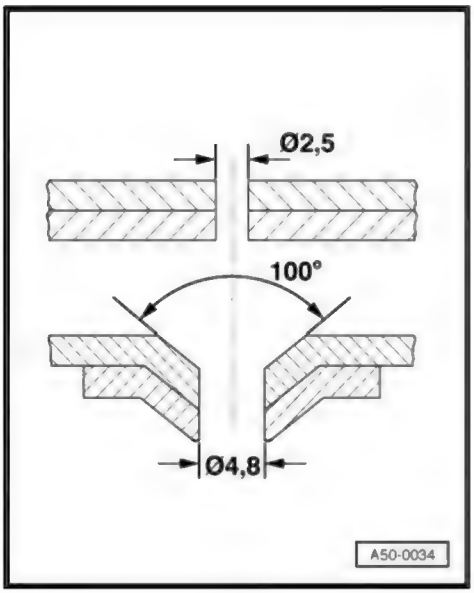
WARNING

Make sure you catch remnants of pop rivets. Any remnants which fall into cavities and can no longer be removed must be bonded in with cavity wax.



Fitting pop rivets

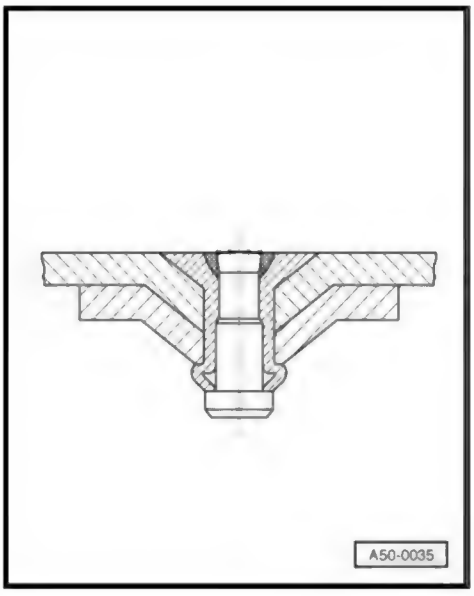
- Match up new parts, position on body and secure in place.
- Place new and old part/backing plate of same material on top of each other and drill a hole (∅ 2.5 mm).
- Detach new parts.
- Use riveting tool to punch drilled holes in all parts.



Note

- *Set riveting tool to material thickness for all operations. Punching enlarges the diameter to 4.8 mm. Punching must face inwards in all parts.*
- *Extruded sections cannot be punched. Drill into new part with extruded section, detach part and enlarge hole in extruded section to ∅ 4.8 mm.*

- Apply adhesive.
- Fit pop rivet and use riveting tool to pull pin out.



Note

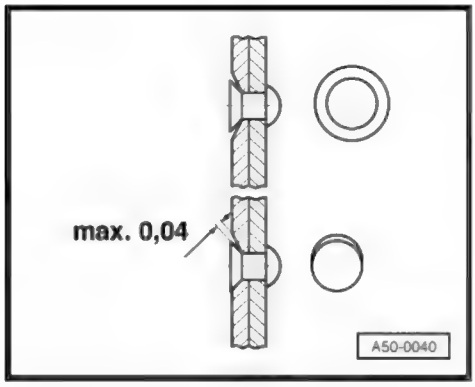
- *All riveted joints have to be bonded when performing repairs in the workshop (unlike in series production). Refer to section on bonded joints* ⇒ page 31 *.*
- *Various pop rivets are available; refer to the Workshop Manual for the relevant vehicle.*

7.2.3 Incorrect riveting

Gaps

Gaps along the entire circumference are not permissible. Gaps along part of the circumference are permissible up to a gap width of 0.04 mm.

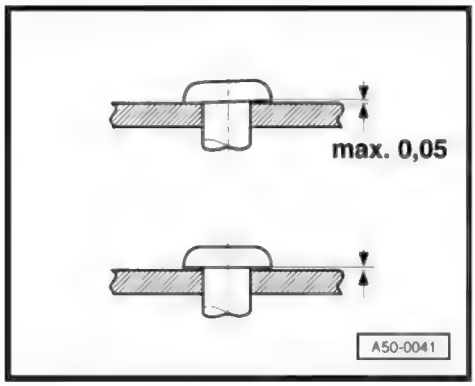
You can use e.g. a tool insert from the riveting set to drive rivet in further, but make sure that closing head and rivet head tolerances are observed.



Rivet heads do not make full contact

Loose rivets are not permissible.

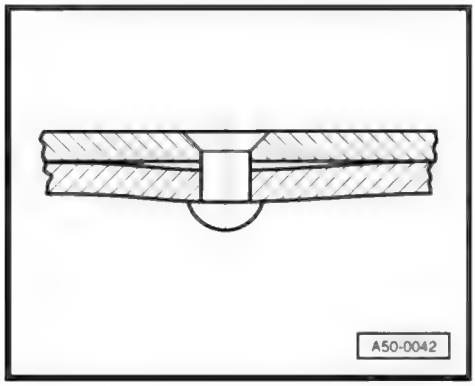
Partial gaps of up to 0.05 mm are permissible.



Swelling at riveted joint

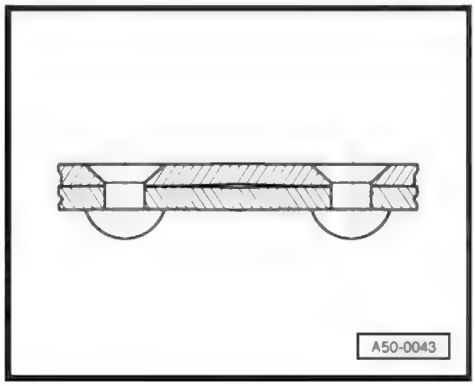
During the riveting process the rivet material is pressed into the gap, subjecting the rivet to bending stress.

Swelling of this kind is not permissible.



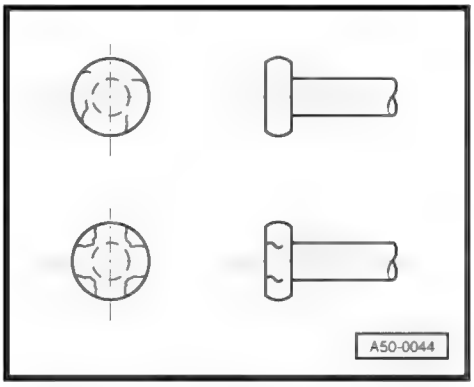
Swelling between riveted joints

Swelling must not exceed a gap width of 0.3 mm.



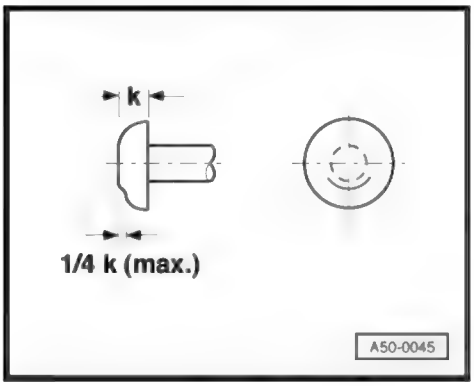
Shear cracks

Cracks which do not overlap (top) are permissible.



Indentations

Permissible indentation depth is 1/4 x rivet head height.

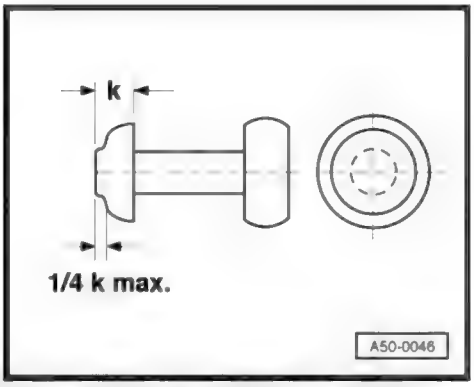


Rings

Rings in the closing head occur if the tool insert used (from riveting set) was too small.

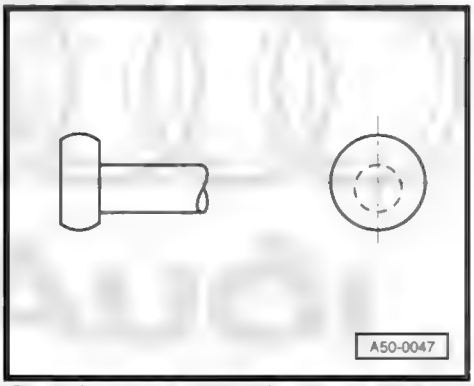
Permissible ring depth is 1/4 x closing head height.

Formation of a ring around the entire circumference is not permissible.



Offset closing head

Offset closing heads are not permissible if closing head makes contact with shank circle and rivet hole is visible.



7.2.4 Kerb-Konus rivets

Coated stainless steel Kerb-Konus rivets are used.

Note

Stainless steel rivets must not be drilled out or ground down due to the risk of corrosion.

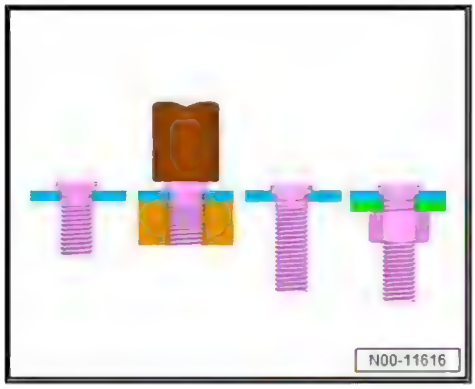
Riveting procedure

A - Apply rivet

B - Pressing-in procedure

C - Setting and punching out

D - Finished Kerb-Konus riveted joint



Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

7.3 Overview of riveting attachments (pairs of tools)

Note

- *This list is intended for general information. Please refer to the operating instructions provided for a description of the procedure and areas of application.*
- *To increase the life of the riveting attachments, please use cutting oil (commercially available).*

D 1 + D 2 - Pressing out ∅ 3.2 mm punch rivet

D 2 + D 3 - Pressing out ∅ 3.2 mm punch rivet

D 2 + D 5 - Pressing out ∅ 5 mm punch rivet

D 3 + D 5 - Pressing out ∅ 5 mm punch rivet

D 4 + D 5 - Pressing out ∅ 5 mm punch rivet

D 5 + D 12 - Punching ∅ 8 mm hole for weld joint

D 6 + D 7 - Punching and countersinking hole for ∅ 4.8 mm pop rivet

D 8 + D 8 - Re-forming metal panel

D 8 + D 9 - Setting ∅ 4 mm solid rivet

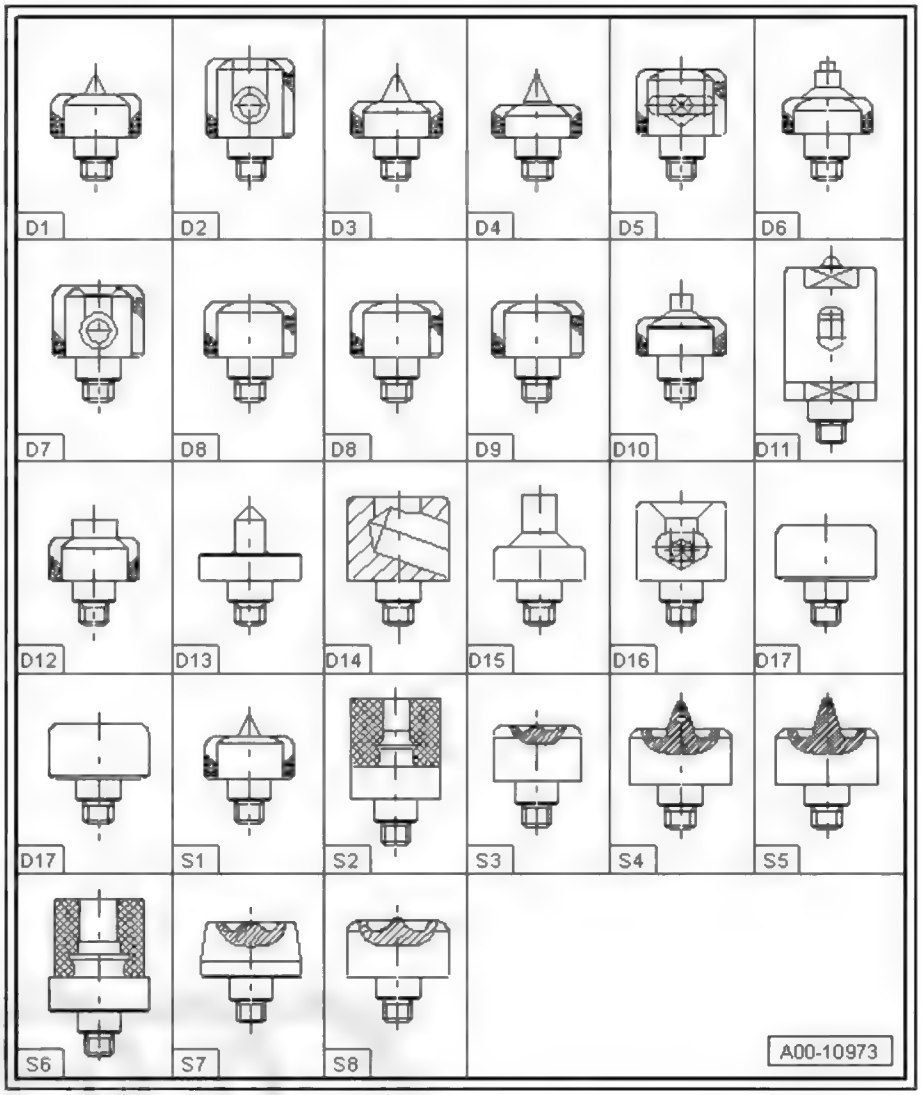
D 10 + D 11 - Punching and countersinking hole for ∅ 4 mm solid rivet

D 13 + D 14 - Pressing out ∅ 5.3 x 7.5 mm punch rivet

D 17 + D 17 - Re-forming metal panel

D 15 + D 16 - Punching and countersinking hole for ∅ 6.0 mm solid rivet

D 17 + D 17 - Setting ∅ 6.0 mm solid rivet



S 1 + D 2 - Pressing out ∅ 3.2 mm punch rivet

S 2 + S 3 - Inserting and setting ∅ 3.2 mm punch rivet

S 4 + D 5 - Pressing out ∅ 5.3 x 5.5 mm punch rivet

S 5 + D 5 - Pressing out ∅ 5.3 x 6.5 mm punch rivet

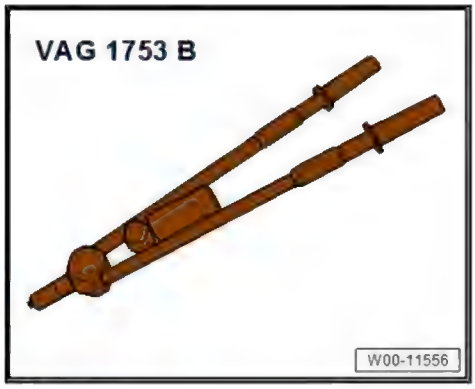
S 6 + S 7 - Inserting and setting ∅ 5.3 x 5.5 mm punch rivet

S 6 + S 8 - Inserting and setting ∅ 5.3 x 6.5 mm punch rivet

7.4 Overview of rivets and tools

⇒ Rep. gr. 00 ; Safety precautions

Pop rivet pliers - VAG 1753 B-



Pop rivet nut pliers - V.A.G 1765-

Pop rivet pliers - VAS 5072 A-

Pneumatic pop riveter - V.A.G 2003 A-

Pneumatic/hydraulic pop rivet pliers - VAS 6759-

Rechargeable riveter - VAS 5279 A-

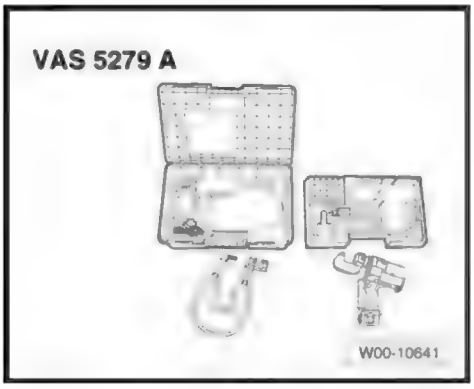
Rechargeable riveter - VAS 843 001-

Compact booster - VAS 6790-

Compact riveter - VAS 6792-

Socket for flow-drill screws - VAS 852 007-

Dent remover - VAS 852 001-



Rivet	Order number Size	V.A.G 1765	VAS 5279	VAS 5072	VAG 1753B	VAG 2003A	VAS 6790	VAS 6792/2	VAS 8430001	VAS 6759	VAS 852007	VAS 852001
Punch rivet	4D0.80 3.217 N 3.35 x 5 mm		x				x		x			
Punch rivet	4D0.80 3.217 Q 3.35 x 4 mm		x				x		x			
Punch rivet	N. 912.295 .02 4.3 x 5 mm		x				x		x			
Punch rivet	4D0.80 3.217.L 5.3 x 5 mm		x				x		x			
Punch rivet	4D0.80 3.217.M 5.3 x 6.5 mm		x				x		x			
Punch rivet	N. 909.261 .02 5.3 x 6 mm		x				x		x			
Punch rivet	N. 911.365 .01 5.3 x 7.5 mm		x				x		x			
Punch rivet	N. 911.348 .01 5 x 4.2mm		x				x		x			
Solid alumi-nium rivet	N. 103.239 .01 4 x 8 mm		x				x		x			
Solid alumi-nium rivet	N 103.240 .01 4 x 12 mm		x				x		x			
Solid alumi-nium rivet	N. 107.440 .01 6 x 10 mm		x				x		x			

Rivet	Order number Size	V.A.G 1765	VAS 5279	VAS 5072	VAG 1753 B	VAG 2003 A	VAS 6790	VAS 6792/2	VAS 843001	VAS 67559	VAS 852007	VAS 8520 01
Solid aluminium rivet	N. 107.441 01 6 x 12 mm		x									
Aluminium pop rivet with countersunk head	4E0.809 .864.A						x	x	x	x		
Aluminium pop rivet with round head	8Z0.809 .864						x	x	x	x		
Flow-drill screws	WHT 003 873 M5 x 25										x	
Flow-drill screws	WHT 006 547 M5 x 20										x	
Flow-drill screws	WHT 007 052 M5 x 18										x	
Threaded rivet	N. 907.163 .01 14 mm				x	x	x	x	x	x		
Threaded rivet	N. 907.162 .01 10 mm				x	x	x	x	x	x		
Threaded rivet	N. 907.161 .01 22 mm				x	x	x	x	x	x		
Threaded rivet	N 907.160 .01 6 mm				x	x	x	x	x	x		

Rivet	Order number Size	V.A.G 1765	VAS 5279	VAS 5072	VAG 1753B	VAG 2003A	VAS 6790	VAS 6792/2	VAS 8430001	VAS 6759	VAS 8520007	VAS 8520001
Pop rivet	WHT. 005.413 .A 6.5 mm Panel thick-ness that can be rive-ted: 3.35 – 5. 35 mm				x	x	x	x	x	x		
Pop rivet	WHT. 005.697 6.5 mm Panel thick-ness that can be rive-ted: 2.8 – 4.8 mm				x	x	x	x	x	x		
Pop rivet	N. 904.692 .02 6.5 mm Panel thick-ness that can be rive-ted: 6.8 – 8.8 mm				x	x	x	x	x	x		
Pop rivet	N. 911.527 .01 6.5 mm Panel thick-ness that can be rive-ted: 4.5 – 7.0 mm				x	x	x	x	x	x		

Rivet	Order number Size	V.A.G 1765	VAS 5279	VAS 5072	VAG 1753 B	VAG 2003 A	VAS 6790	VAS 6792/2	VAS 843 001	VAS 6759	VAS 852007	VAS 852001
Pop rivet	N. 909.236.01 4.8 mm Panel thickness that can be riveted: 2.4 – 4.8 mm				x	x	x	x	x	x		
Pop rivet	N. 905.344.03 4.8 mm Panel thickness that can be riveted: 1.5 – 3.5 mm				x	x	x	x	x	x		
Pop rivet	N. 906.924.02 4.8 mm Panel thickness that can be riveted: 2.4 – 5.0 mm				x	x	x	x	x	x		
Pop rivet	4S0.843.658				x	x	x	x	x	x		
Pop rivet bolt	WHT. 005.180	V.A.G 1765 C/2										
Pop rivet bolt	N 910 011 01	V.A.G 1765 C/4										
Pop rivet nut	N 910 377 01 M10	V.A.G 1765										
Pop rivet nut	N 908 568 02 M8	V.A.G 1765										

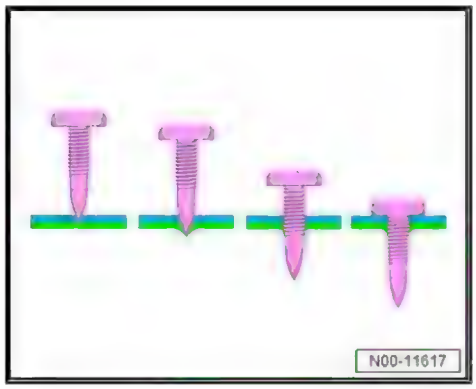
Rivet	Order number Size	V.A.G 1765	VAS 5279	VAS 5072	VAG 1753B	VAG 2003A	VAS 6790	VAS 6792/2	VAS 843001	VAS 6759	VAS 852007	VAS 8520001
Weld stud	VAS 852.001 /1 5 mm							x				x
Weld stud	VAS 852.001 /2 4 mm							x				x

⇒ Rep. gr. 00 ; Safety precautions

7.5 Overview of rivets used for repair measures

In production	For repair measures	To be used
Punch rivet, ∅ 3.3	Aluminium/ aluminium	Solid aluminium rivet: ∅ 4 mm N.103.239.01 N.103.240.01
Punch rivet, ∅ 5.3	Aluminium/ aluminium	Solid aluminium rivet: ∅ 6 mm N.107.440.01 N.107.441.01
Punch rivet, ∅ 3.3 and friction elements	Aluminium/ steel	Pop rivet: ∅ 4.8 mm N.905.344.03 Panel thickness that can be riveted: 1.5 - 3.5 mm N.906.924.02 Panel thickness that can be riveted: 2.4 - 5.0 mm
Punch rivet, ∅ 5.3 and flow-drill screws (where applicable)	Aluminium/ steel	Pop rivet: ∅ 6.5 mm WHT.005.413.A Panel thickness that can be riveted: 3.35 - 5.35 mm WHT.005.697 Panel thickness that can be riveted: 2.8 - 4.8 mm N.911.527.01 Panel thickness that can be riveted: 4.5 - 7.0 mm N.904.692.02 Panel thickness that can be riveted: 2.4 - 5.0 mm

7.6 Flow-drill screws (FDS)



When flow-drill screws are used, the lower component is heated up by the frictional heat generated by the screw as it is turned. The self-tapping flow-drill screw is then screwed into the soft aluminium.

Maintenance of joints where flow-drill screws (FDS) are used:

Note

- *The Audi R8 employs flow-drill screws which can be renewed using socket for flow-drill screws - VAS 852 007- .*
- *The repair methods required for the all-aluminium body parts are the same as the existing methods for the other Audi models with aluminium body.*
- *The advantages of threaded fasteners for workshop repairs can now be used to the full with the aid of this tool.*

The process for creating an FDS joint is illustrated below using three different examples.

7.6.1 Creating an FDS joint (upper panel with pre-drilled holes)

- Remove flow-drill screws using socket for flow-drill screws and separate joint.
- Take off upper panel.
- Prepare joints for adhesive application.
- Clean bonding area with cleaning solution.
- Prepare bonding area with silicate stone and clean.
- Apply aluminium primer to bonding surfaces using applicator.
- Apply 2-component epoxy adhesive to entire area using pneumatic glue gun.
- Fit new part in position and secure with new screws using socket for flow-drill screws (tighten to 5Nm).

7.6.2 Creating an FDS joint (upper panel without pre-drilled holes)

- Remove flow-drill screws using socket for flow-drill screws and separate joint.
- Take off upper panel.
- Insert hole finders into existing FDS threads.
- Fit new part in position.
- Mark holes on new part with light blows from a rubber-headed hammer.

Note

Allow for offset resulting from hole finders; if necessary mark just one surface at a time.

- Take off upper panel.
- Drill 7mm Ø holes in new part.

- Prepare joints for adhesive application.
- Clean bonding area with cleaning solution.
- Prepare bonding area with silicate stone and clean.
- Apply aluminium primer to bonding surfaces using applicator.
- Apply 2-component epoxy adhesive to entire area using pneumatic glue gun.
- Fit new part in position and secure with new screws using socket for flow-drill screws (tighten to 5Nm).

7.6.3 Creating an FDS joint (when renewing upper and lower panels)

- Remove flow-drill screws using socket for flow-drill screws and separate joint.
- Take off both panels.
- Drill 4 mm Ø holes in both panels at the same distances as on the original joint.
- Detach new parts.
- Drill out 4 mm Ø holes in upper panel to 7 mm Ø.
- Prepare joints for adhesive application.
- Clean bonding area with cleaning solution.
- Prepare bonding area with silicate stone and clean.
- Apply aluminium primer to bonding surfaces using applicator.
- Apply 2-component epoxy adhesive to entire area using pneumatic glue gun.
- Fit new part in position and secure with new screws using socket for flow-drill screws (tighten to 5Nm).

Repair kit for FDS joints

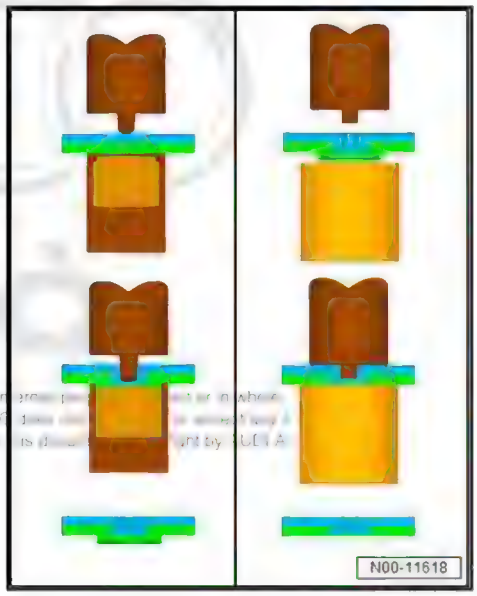
The repair kit can be used to mark the holes on new parts where flow-drill screws (FDS) are used. With the aid of the hole finders, it is possible to transfer the FDS hole positions on aluminium Audi vehicles when making repairs. The old FDS screws are first loosened with the aid of the socket. The damaged panel is then removed. Using the ring spanner (supplied with the repair kit), the hole finders are now screwed into the existing holes in the aluminium panel not being renewed. The new aluminium panel is then fitted on the vehicle and fixed in position with clamps. Using soft blows with a rubber hammer, the holes from the existing panel can now be transferred to the replacement part with the aid of the hole finders. After being marked with the hole positions, the replacement part is removed. Holes are predrilled at these points. It is then possible to secure the new part to the body with flow drill screws using the socket.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

7.7 Clinching

Clinching is a joining process which is used to join sheet metal without additional materials. It can be classified either as a joining process or as a forming process, as the joint is made by forming the material.



Repair instructions

- Start by making separating cuts where necessary.
- Remove old flange by stripping it off.
- Align remaining flange.

Note

Set riveting tool to material thickness for all operations.

- Detach damaged part (use a chisel if necessary).
- Match up new parts and fit solid rivets or pop rivets as specified in Body Repairs workshop manual.

Equipment

Only equipment which is listed as approved in the workshop equipment catalogue may be used.

8 Separating techniques in body welding; areas of application

8.1 Drilling

Drilling is used to loosen spot welds and rivets. When performing drilling work, you must make sure that the components located behind are not damaged. When loosening two-layer and multi-layer welded joints, the panel remaining on the vehicle must not be weakened any more than is necessary. Remove (vacuum up) all metal particles carefully from cavities after performing drilling work.

8.2 Saw-cutting

Two different types of saw are commonly used for saw-cutting work:

- Short-stroke pneumatic saw
- Oscillating saw

Short-stroke pneumatic saws have the following advantages:

- Cutting is performed quickly.
- Radius sawing is possible.
- Can also be used for very angled profiles.

Oscillating saws have the following advantages:

- Clean, straight cuts.
- Low penetration depth makes them particularly suitable for two-layered panels.

Note

Remove (vacuum up) all metal particles carefully from cavities after performing sawing work.

8.3 Grinding

Grinding can be a very useful alternative to drilling, especially when loosening high-strength welded joints. Grinding can be used very effectively to loosen spot welds, laser-welded joints and brazed joints. Again, it is important to ensure that the materials located behind are not weakened or damaged any more than is necessary.

Disadvantages of grinding:

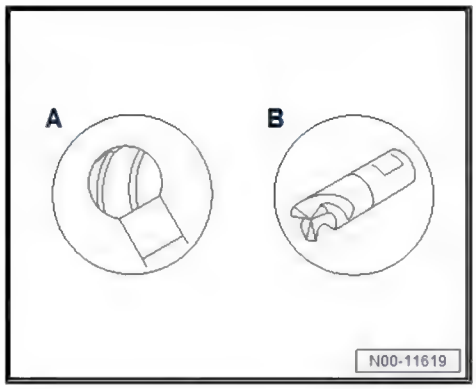
- Due to flying sparks, extensive safety precautions on and around the vehicle are necessary.
- Higher temperatures are generated than during drilling; this results in more damage to the remaining material and the anti-corrosion material.

8.4 Milling

In body repairs, milling work is performed using either a spherical cutter -A- or a BTR cutter -B-.

Spherical cutters are used to loosen spot welds if, due to lack of space, it is not possible to use a BTR cutter to do so.

When working with the BTR cutter, it is important to ensure that the blades remain straight in the high-strength steel. The blades can break easily as they become harder; you should therefore always perform the work with a suitable tool (do not use a hand-held drill).



8.5 Separating bonded joints

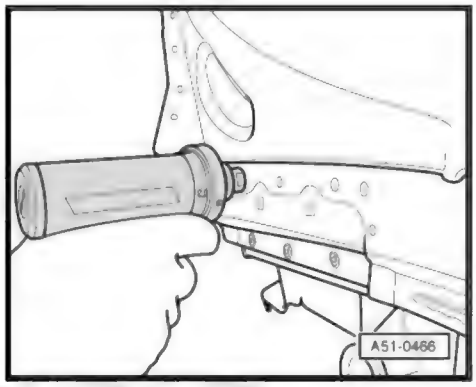
Bonded joints on the body can be separated by applying heat. The adhesives used during vehicle manufacture and repairs are destroyed at temperatures between 180 and 200°C.

> WARNING
>
> *Toxic gases are generated when separating bonded joints; it is therefore important to ensure good ventilation and suitable extraction of smoke in the area where work is being performed.*

8.6 Pulling out rivets which are only accessible from one side

Work sequence

- Remove paint and oxide layer from rivet head and attachment point for earth clamps.
- Attach earth clamps as close as possible to rivets.



- Weld on weld stud to rivet.
- Pull out rivet using weld stud and specified tools.

> Note
>
> *For information on tools and materials, refer to the Workshop Manual for the relevant vehicle.*

9 Surface repairs

Note

Always pay attention to anti-corrosion materials on inside when performing dent removal work.

9.1 Dent removal techniques for sheet steel

9.1.1 "Classic" dent removal procedure (with paint damage)

The classic procedure for removing dents (with hammer and counterholding) is now only rarely used on modern vehicle bodies.

Disadvantages of this technique are its limited area of application (design-related) and the overstretching of the material inherent in this method. The resulting excess material often has to be shrunk thermally, which in turn has major disadvantages in terms of material strength and corrosion protection.

9.1.2 "Pressing" dent removal procedure (no paint damage)

This removal technique for dents without paint damage is mostly used for minor damage caused by parking incidents or hailstones. The dent is pressed gently outwards from the inside using circular movements in multiple stages around the centre of the dent; this enables the dent to be straightened out without any cracks forming in the paintwork.

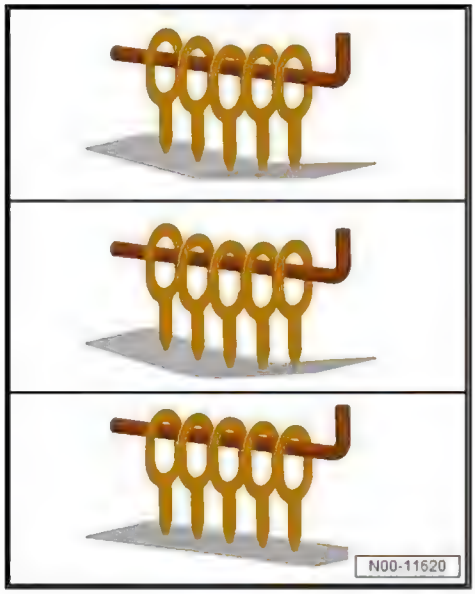
A - Example of a pressing set

9.1.3 "Pulling" dent removal procedure (working from the outside)

This dent removal procedure, which is performed working from the outside, is used both as a bonding technique with no paintwork damage and as a technique with paintwork damage. In this procedure, pulling tabs/pins (or similar) are welded on. The choice of which technique to use depends on the type of damage. Both techniques involve pulling the dent out of the panel from the outside. The slowness of the re-forming process means that the amount of tension caused in the material structure is significantly reduced. For this reason, the technique is also referred to as "gentle" or "shock-free" re-forming.

These dent removal techniques have the following advantages:

- Reduced material overstretching
- Minimal damage to anti-corrosion material
- Little removal/assembly work required on vehicle
- Original joint is maintained (unlike if components are renewed)



9.2 Dent removal procedures for aluminium panels

Note

Aluminium components must be covered when grinding and welding steel parts. If metal swarf/dust makes contact with aluminium, remove immediately to avoid contact corrosion.

WARNING

Use separate tools for steel and aluminium.

Recommendation: aluminium tool kit in workshop trolley (refer to workshop equipment catalogue).

The dent removal techniques for aluminium components are essentially similar to those for steel components. However, due to the different material properties there are a few points which must be observed:

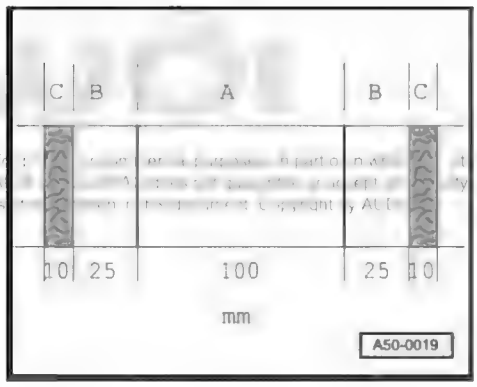
- The danger of over-stretching the material is greater with aluminium than with steel.
- Sharp-edged or hard panel beating tools (e.g. steel hammer) should not be used. Use plastic, wood or aluminium hammers instead.
- Unlike the procedure for steel panels, you should begin in the middle of the dent when removing dents on aluminium panels.
- If material stretching should occur, it can be eliminated by heating and shrinking.

WARNING

Do not exceed temperatures of 150°C when performing shrinking work as this can damage the component.

Note

If a crack or rupture appears during panel beating, the part must be renewed!



Temperature monitoring during heating

Tempering colours (colour changes) are not evident when heating aluminium. The temperature must therefore be determined using heat strips.

Heat strips change colour at certain temperatures.

A - Heating zone

B - Clear zone

C - Heat strip

9.3 Bonded joints with aluminium

> **WARNING**
>
> *Pre-treatment applies to old flange only.*

- Remove remnants of adhesive, paint, wax, etc.
- Sand bonding surface down to bare metal using a clean sanding disc (grit size P 80 or P 100).
- Use clean brush to remove sanding dust.
- Clean bonding surfaces with cleaning solution - D 009 401 04- .
- Treat flanges with silicate stone - DA.009.800 - and holder - V.A.G 1931- .
- Apply a thin coat of aluminium primer - DA 009 801 - using applicator - D 009 500 25 - and allow to flash off.

A silicate adhesive layer is formed which ensures long-term durability of the bonded joint. The surface becomes matt.

Do NOT use solvents.

> **WARNING**
>
> *Mask bonding surfaces when painting inner sides.*

Parts must be joined and secured in position within 30 minutes as otherwise the formation of a surface skin will result in inadequate adhesion at the flanges.

- Fit rivets and wipe off emerging adhesive.

At temperatures up to 20° C, rivets must be fitted within 90 minutes and at temperatures above 20° C within 40 minutes starting from application of adhesive.

> **Note**
>
> - *For large parts, e.g. roof, the assistance of a second person is required, as otherwise the adhesive will dry before work is completed.*
> - *In the event of interruptions lasting up to 30 minutes, press out and discard an approx. 100 mm long bead to ensure that new material is properly mixed. In the event of interruptions lasting longer than 30 minutes, replace mixing nozzle and press out a 100 mm long bead. If several cartridges are required for repair work, the same mixing nozzle can be used.*

9.4 Processing metal and aluminium filler

Processing metal and aluminium filler has numerous benefits:

- Very good adhesive properties on bare surfaces
- Thicker layers possible than with polyester filler
- If work is performed correctly, less tendency to shrink subsequently or sag
- Can also be used around adhesive bonds as it does not build up much heat

- No visible differences in transition areas

Note

Only approved filler materials must be used.

WARNING

- *Note processing information on containers.*
- *Before the filler is applied, all adhesive residue (or similar) must be removed from the gaps.*
- *If using infrared drying, the surface temperature must be monitored.*
- *Self-regulating infrared dryers tend to make measurement errors on smaller surfaces; this can cause damage to components.*

9.5 Processing unleaded tin

Note

- *It is no longer permissible to perform work using tin; this includes unleaded tin.*
- *To produce an accurately aligned surface, use the materials listed on* *⇒ page 53* *.*

9.6 Definition of “accurately aligned surface” / handover to paint shop

Repaired areas must be prepared so that all surfaces, swage lines and panel edges are accurately aligned with the surrounding body contour.

The following requirements must be met:

- After body repair work such as dent removal, welding and filling, etc., the repaired areas and parts must be dry-sanded with a grit size of at least P 80.
- The repaired surfaces must be prepared so that the required paint finish can be achieved in no more than two stages.

Note

Only approved filler materials must be used. Lead-free and leaded body solder are not approved.

10 Performing straightening work on body structure

10.1 Straightening

In series production, the vehicle body and floor sections are primarily manufactured from cold-formed deep-drawn sheet metal panels. For this reason, the straightening of areas damaged in an accident should be carried out in the same manner.

If the extent of the damage makes it impossible to straighten the part in this manner, the damaged part should not be cut out until the adjacent surfaces have been straightened.

10.2 Separating cuts

Separating cuts affecting the fatigue strength of the body and therefore also vehicle reliability and roadworthiness must be made as instructed in the relevant Body Repairs workshop manual.

10.3 Body sub-parts and part sections

A sub-part is a section of a complete part (e.g. end section at front and rear), which is already cut to size when it is supplied by the spare parts warehouse.

- Part sections, on the other hand, must be cut to size from replacement parts by the workshop itself. The methods to apply in each case are described and illustrated in the Body Repairs workshop manual.
- As the use of "sub-parts"/"part sections" and special tools and equipment has an influence on the time required, special tools and equipment are listed separately in the description of repair operations.

11 Corrosion protection

Corrosion protection as provided when vehicle leaves the factory must be restored after repairs, using materials which have been approved by the vehicle manufacturer.

The standard factory corrosion protection is described in the general and vehicle-specific ⇒ Paintwork manual .

11.1 Corrosion protection for attachments and welded parts

- Bare metal areas must be primed immediately after repairs.
- Holes must always be deburred.
- Always apply welding primer/structural adhesive to both sides of welding flanges (in accordance with Workshop Manual).
- Prime inside and outside of seam areas prior to sealing.
- Sealing compound must only be applied to primed panel sections.
- Make sure you seal overlaps and edges of metal panels, butt joints, welding seams etc. completely using sealing compound.
- Restore paintwork structure as described in Paintwork manual.
- Restore underseal using long-life underseal material.
- All cavities in the repaired area must be sealed after applying topcoat.
- Separating cuts (e.g. in side panel) must be fully sealed.
- Clear the water drains after cavity protection material has dried.

11.1.1 Contact corrosion

Contact corrosion can occur if unsuitable fasteners (bolts, nuts, washers etc.) are used.

For this reason, only fasteners with a special surface coating are fitted.

In addition, all rubber and plastic parts and all adhesives are made of non-conductive materials.

Always install new parts if you are not sure whether parts are suitable for re-installation.

11.2 Cavity sealing

The standard factory corrosion protection is described in the general and vehicle-specific ⇒ Paintwork manual .

WARNING

- *Before beginning work of this nature, you must read the safety data sheet for precautionary measures and safety advice.*
- *The usual precautionary measures for chemical products must be heeded for all products, even those which are not subject to labelling requirements.*

Note

Depending on the type of cavity for which sealing work is performed, drying may take several days. Adequate ventilation must be ensured during the drying process.

Caution

- *Functional components such as brake systems and exhaust systems must not be treated.*
- *Rubber and plastic components should also not be treated.*

Cleaning

- Anti-corrosion agents can be wiped off easily.
- Plastic cleaners are suitable for cleaning off dried-on materials.
- Cleaning with a steam cleaner is possible for larger surfaces. Any spray on painted surfaces should be removed immediately.

12 Plastic repairs

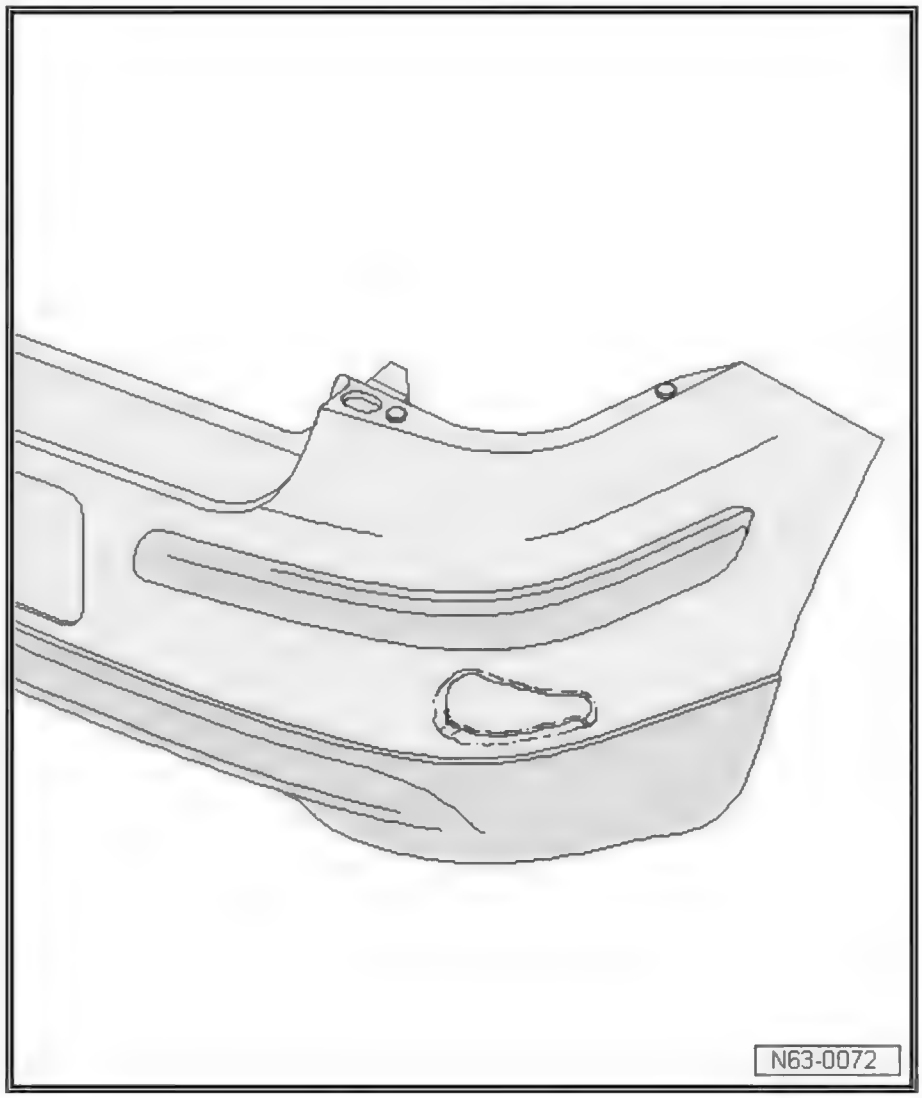
WARNING

Please observe all relevant safety regulations. Safety-related components that would no longer meet functional requirements after a repair (e.g. the absorption of impact energy) must not be repaired.

Repairs that can be performed using plastic repair set include repairs to painted plastic body panels, such as the bumpers or exterior mirror housings. Before starting a repair it is important to check carefully whether the repair is feasible and economical (i.e. repair or fit new parts?).

Plastic panels with a structured surface can also be repaired in this way. However, it will not be possible to achieve quite the original surface quality of a new part.

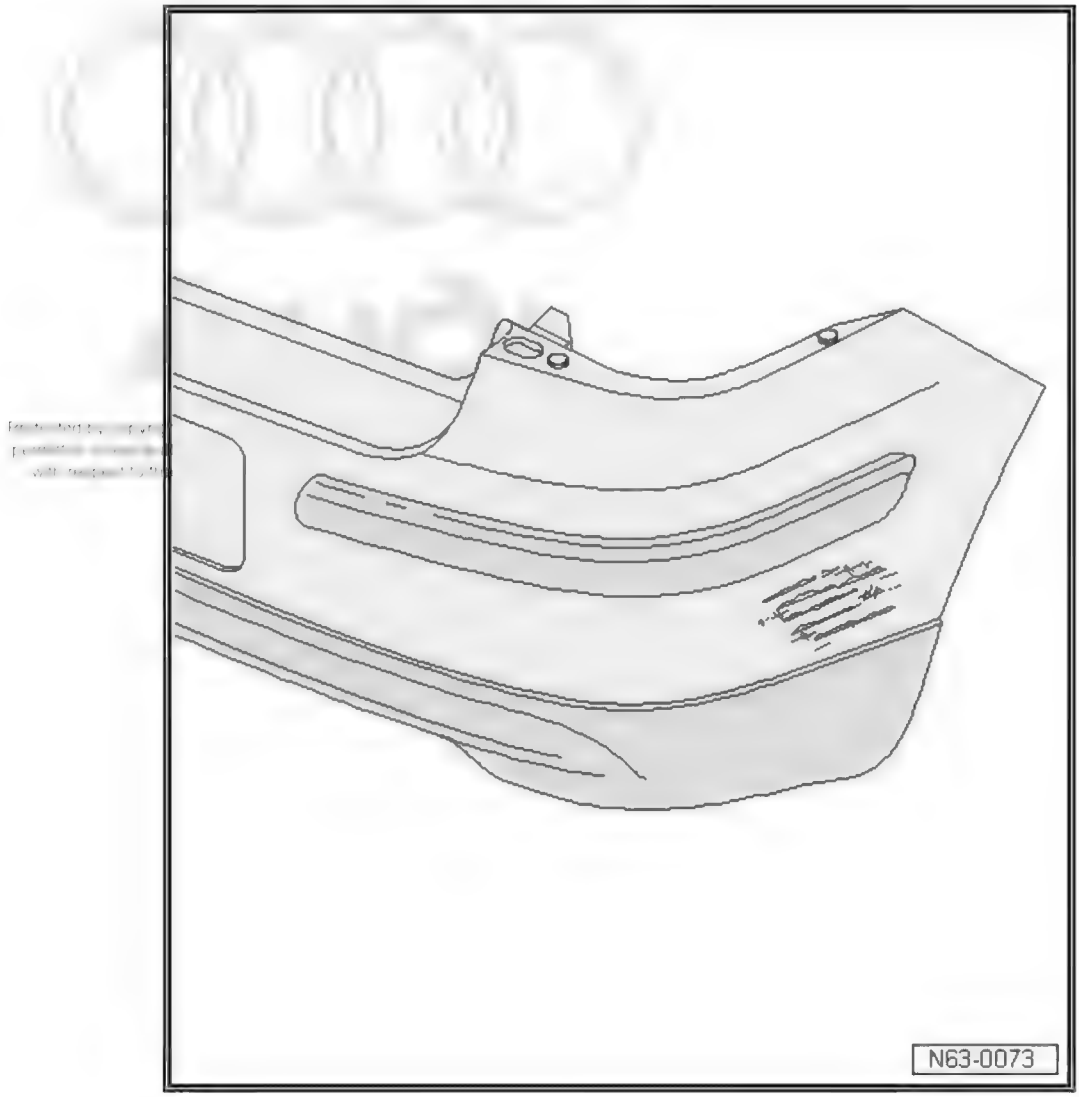
12.1 Repairing dents



– First clean and dry the damaged panel.

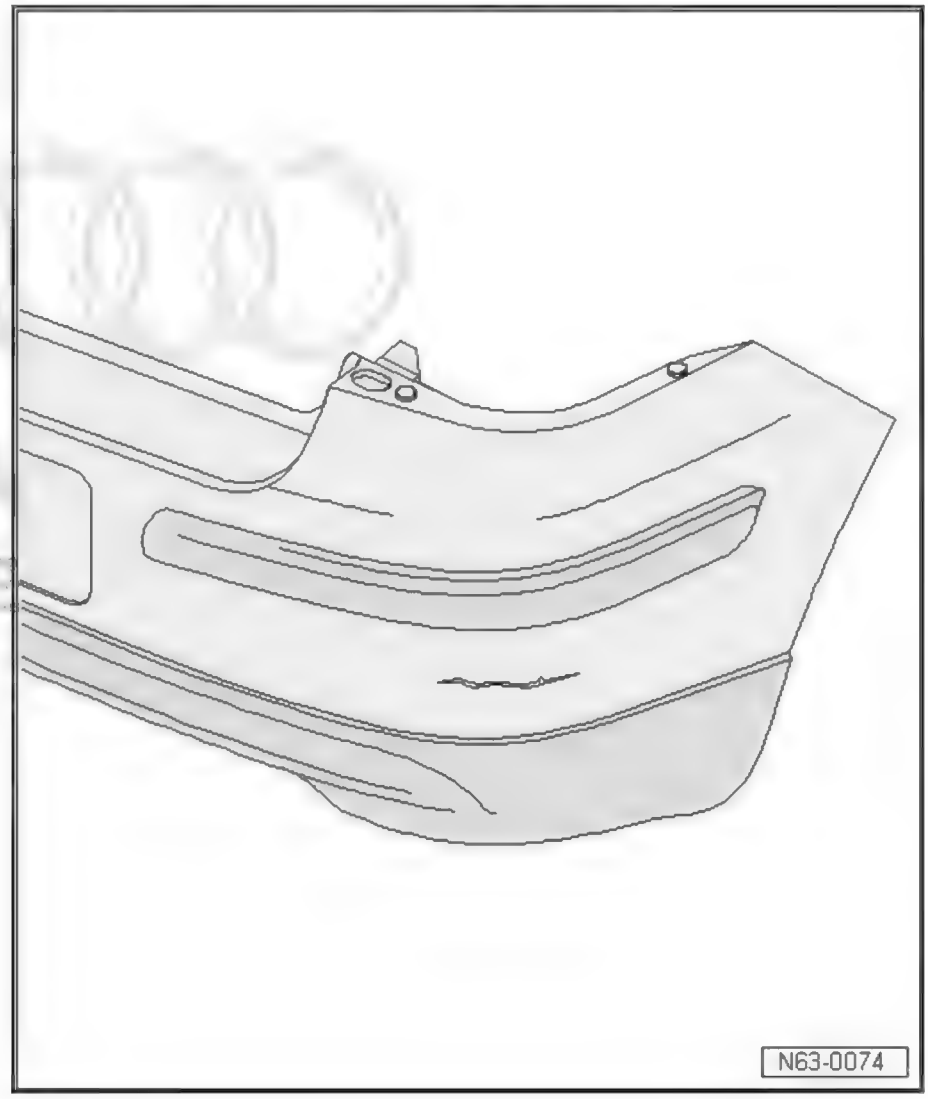
- Now apply heat to the affected area using a hot air blower until the dent can be pressed out with a suitable tool.
- Lightly sand down the dented area with abrasive paper (120 grade).
- Then clean the repaired area with cleaning fluid. Allow to dry for 5 minutes.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Now you can fill any remaining surface irregularities with adhesive and smooth down with a scraper.
- The hardening process can be speeded up with the aid of an infra-red lamp. Set to 15 minutes at 60°-70°C.
- Now rub down the repaired surface with sandpaper (120 grade).
- Remove sanding dust.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Apply paint finish as specified in the Audi paintwork manual.

12.2 Repairing scratches



- First clean and dry the damaged panel.
- Remove material projecting above the surface with grade 80 sandpaper.
- Then clean the repaired area with cleaning fluid. Allow to dry for 5 minutes.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Now you can fill any remaining surface irregularities with adhesive and smooth down with a scraper.
- The hardening process can be speeded up with the aid of an infra-red lamp. Set to 15 minutes at 60°-70°C.
- Now rub down the repaired surface with sandpaper (120 grade).
- Remove sanding dust.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Apply paint finish as specified in the Audi paintwork manual.

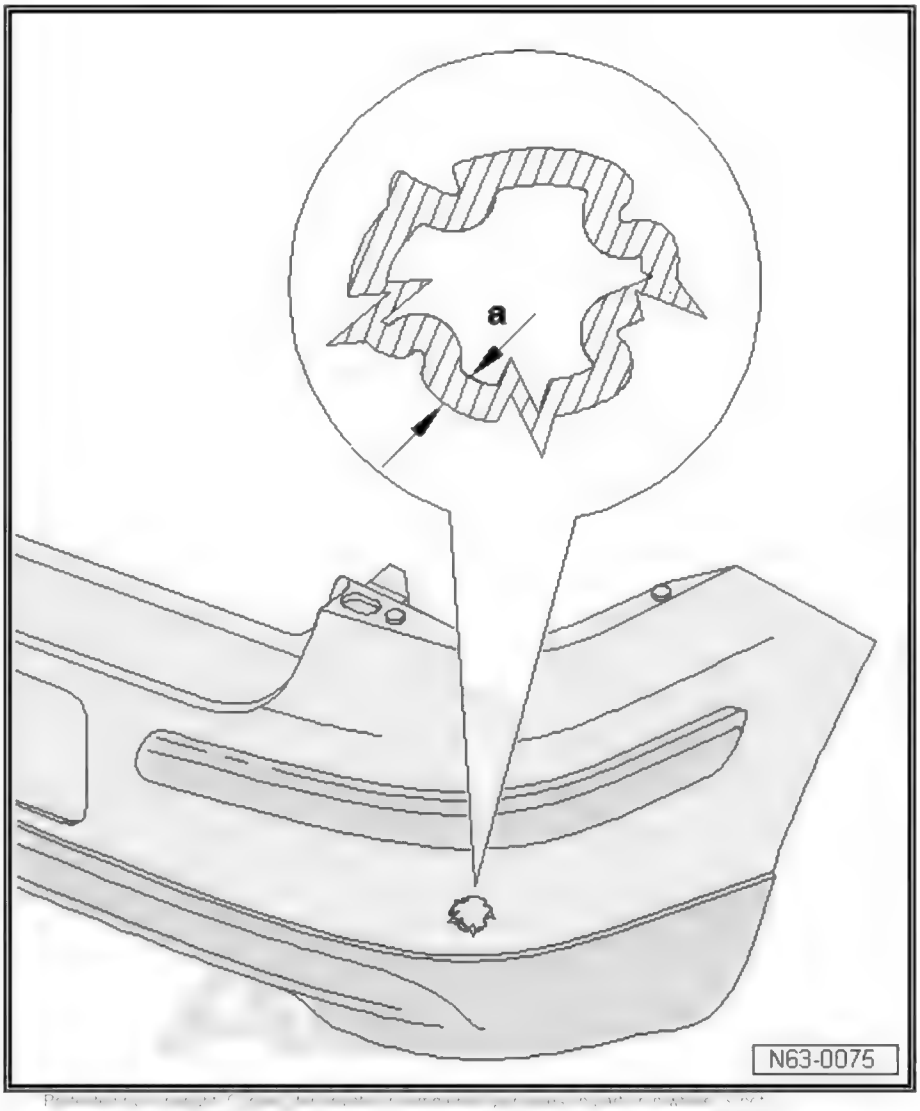
12.3 Repairing cracks and tears (up to a length of 100 mm)



- First clean and dry the damaged panel.

- By drilling into the crack (5 mm) and grinding out to a V-shaped groove, you can remove irregularities caused by stretching of the plastic.
- Then clean the repaired area with cleaning fluid. Allow to dry for 5 minutes.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- As the next step, bond in a reinforcing mat onto the reverse side of the panel using adhesive so that it overlaps the damaged section by at least 20 mm.
- The hardening process can be speeded up with the aid of an infra-red lamp. Set to 15 minutes at 60°-70°C.
- Now you can fill in the hollowed-out area on the front of the panel using adhesive and smooth down with a scraper.
- Again, the hardening process can be speeded up on the front of the panel with the aid of an infra-red lamp.
- Now rub down the repaired surface with sandpaper (120 grade).
- Remove sanding dust.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Apply paint finish as specified in the Audi paintwork manual.

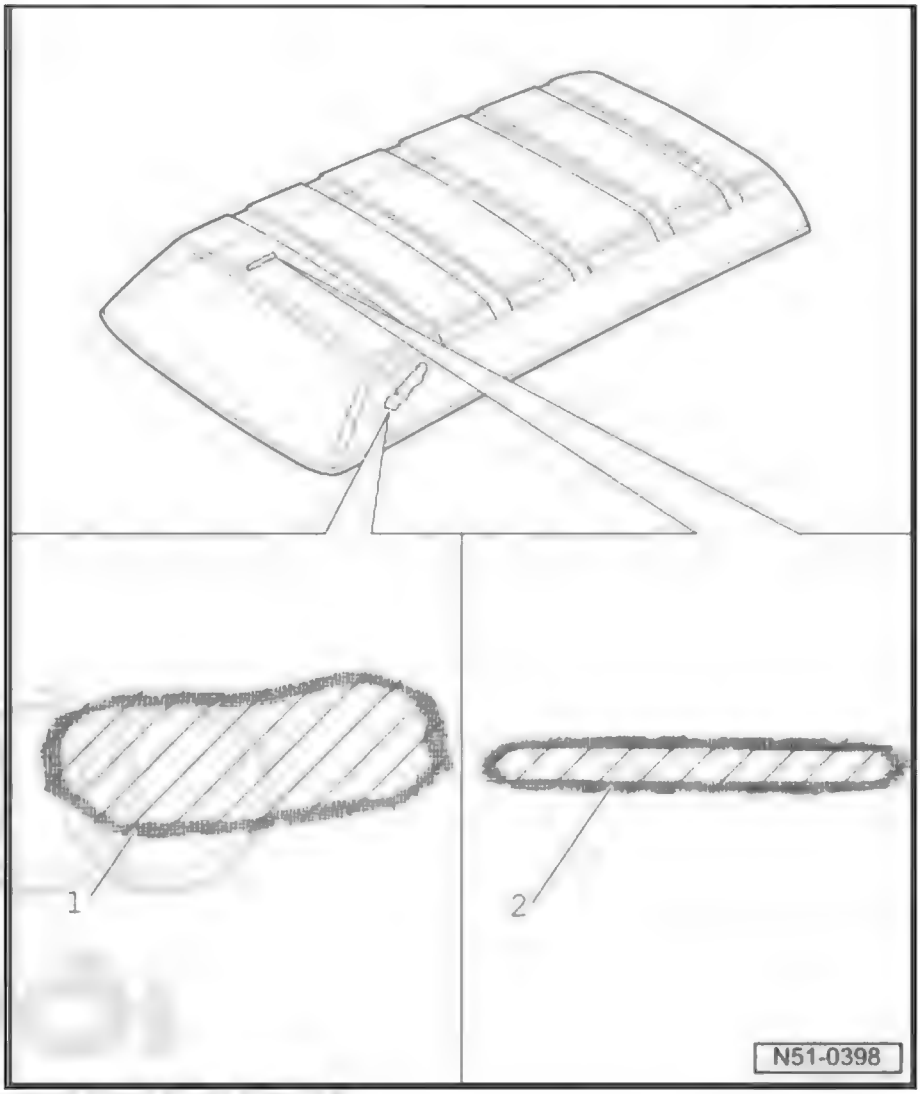
12.4 Repairing holes (up to 30 mm diameter)



- First clean and dry the damaged panel.
- Using abrasive paper (120 grade), sand down the edges of the hole to a funnel shape (a = 10 - 20 mm).
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Roughen the repaired surface with sandpaper (120 grade).
- Then clean the repaired area with cleaning fluid. Allow to dry for 5 minutes.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- As the next step, bond in a reinforcing mat onto the reverse side of the panel using adhesive so that it overlaps the damaged section by at least 20 mm.
- The hardening process can be speeded up with the aid of an infra-red lamp. Set to 15 minutes at 60°-70°C.
- Now you can fill in the hollowed-out area on the front of the panel using adhesive and smooth down with a scraper.
- Again, the hardening process can be speeded up on the front of the panel with the aid of an infra-red lamp.
- Now rub down the repaired surface with sandpaper (120 grade).

- Remove sanding dust.
- Spray on a thin coat of primer and allow to dry for 10 minutes.
- Apply paint finish as specified in the Audi paintwork manual.

12.5 Plastic repairs (glass fibre materials)



WARNING

Please observe all relevant safety regulations. Safety-related components that would no longer meet functional requirements after a repair (e.g. the absorption of impact energy) must not be repaired.

1- Rupture/hole

- Glass fibre mat, polyester resin and hardener

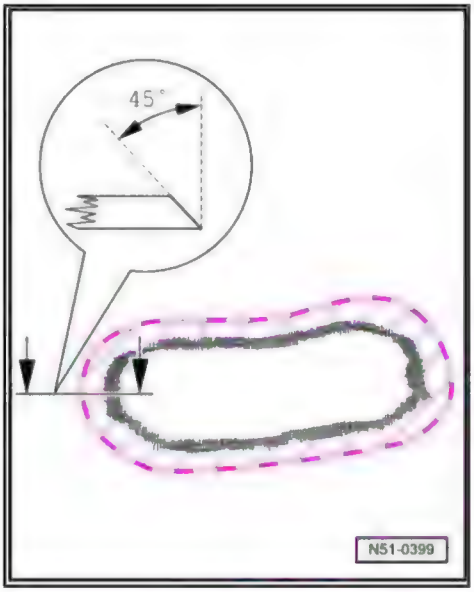
2- Surface damage

- Glass fibre reinforced polyester resin, hardener

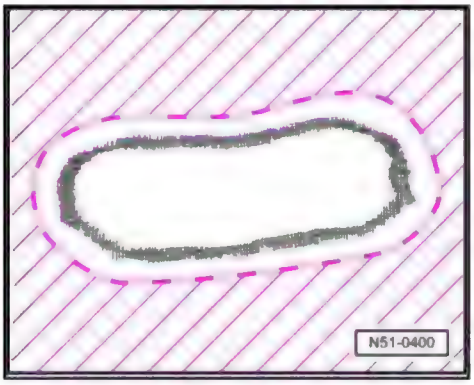
Note

Observe manufacturer's instructions when using materials.

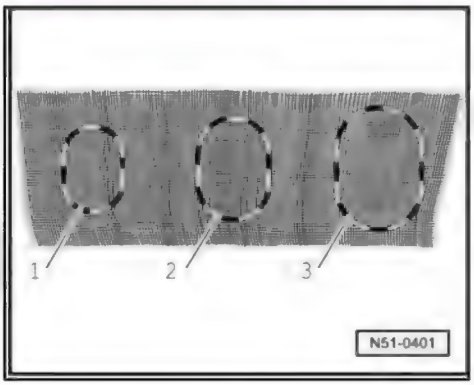
12.5.1 Procedure for repairing ruptures/holes



– Grind down edge of rupture/hole all round to an angle of 45°.



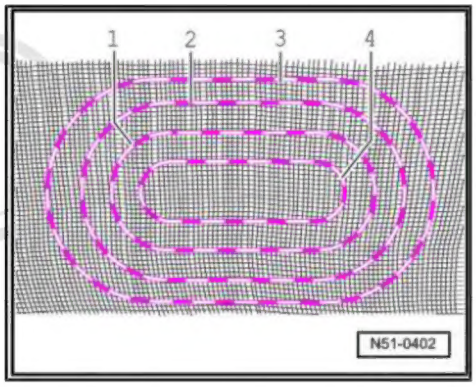
– Lightly sand an area approx. 100 mm wide around the rupture/ hole (hatched area) using 150 grade abrasive paper and clean with silicone remover.
– Cut three glass fibre mats to shape: -1- to overlap rupture/hole by approx. 25 mm, -2- overlap approx. 50 mm, -3- overlap approx. 75 mm.



Note

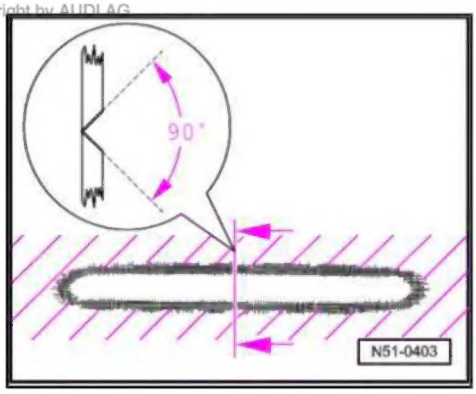
For large ruptures/holes it is recommended to use a styrene block as a support. Cover styrene with commercially available unprinted PE synthetic foil to prevent contact with polyester resin. Then secure the prepared support to the inside of the rupture/hole with adhesive tape.

Applying glass fibre mats

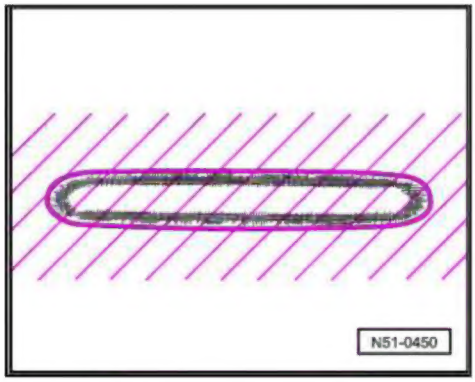


- Mix polyester resin (observe manufacturer's instructions).
- Apply thin coat of polyester resin to rupture/hole.
- Soak smallest glass fibre mat -1- completely in polyester resin and apply to rupture/hole -4-.
- After applying, remove air bubbles in polyester resin immediately with a pointed tool.
- After applied material has hardened, sand down surface using 120 grade abrasive paper.
- Clean repaired section with silicone remover.
- Repeat work sequence for the second -2- and third -3- glass fibre mats.

12.5.2 Procedure for repairing surface damage



- Cut damaged surface to a V shape.
- Sand area approx. 50 mm wide around damaged surface (hatched area) using 150 grade abrasive paper.



- Clean repaired section with silicone remover.
- Mix glass fibre reinforced polyester resin (observe manufacturer's instructions) and apply to repaired section (hatched area).
- After applied material has hardened, sand down repaired section and clean with silicone remover.

13 Glass repairs

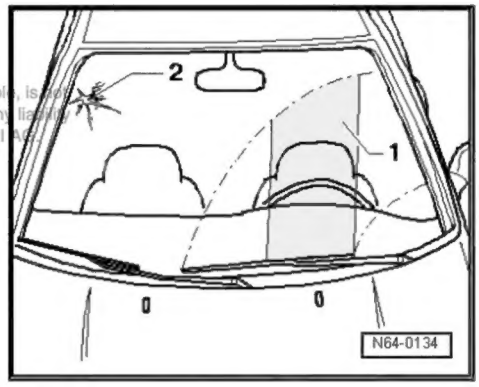
13.1 Repairing windscreens

As a cost-saving alternative to renewing windscreens which are bonded on, it may be possible in some cases to repair windscreens damaged by stone chipping.

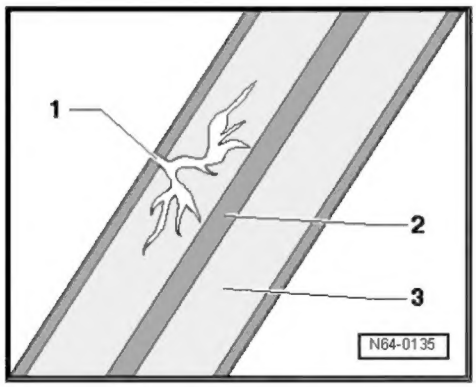
Tinted windows and windows with a coloured sun strip, insulated glass and/or a heating function can also be repaired, as the tinting and heating is provided by a PVB layer in the window glass.

The windscreen should be repaired rather than renewed if the requirements specified below are met.

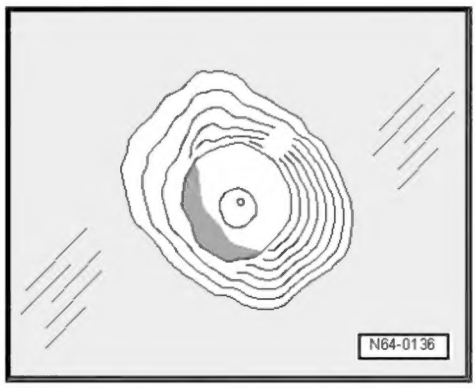
13.1.1 Requirements



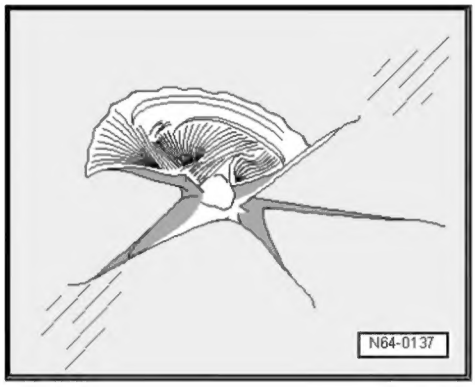
- Damaged area must not be within direct field of long-distance vision -1-. This field corresponds to a roughly 29 cm wide strip (A4 landscape format) centrally positioned in the driver's direct line of vision in the direction of travel and extending to the top and bottom of the wiping area.
- The cracks radiating from the damaged area -2- must not be longer than 50 mm and must not run outwards to the edge.
- Diameter of impact point -1- must not exceed 5 mm.
- Coloured film -2- or inner glass -3- must not be damaged.
- There must be no dirt or moisture in lower area of cracks.
- Therefore the time elapsed since the damage occurred must not be too long.



The following types of damage can be repaired, however the damaged area must NOT be not located in the field of long-range vision or at the edge of the windscreen:

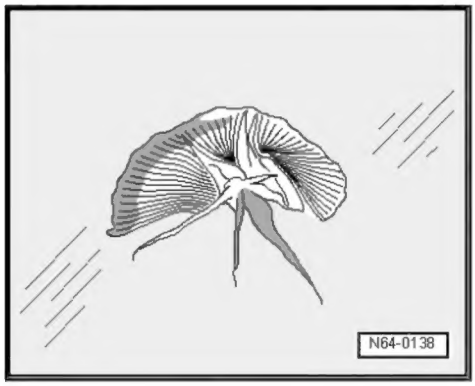


Crater



Compound break

Star and crack



13.1.2 Description of repair work

For details of the repair procedure, refer to the instructions in the repair kits approved in the workshop equipment catalogue.

- Repairs must be performed in an area protected from direct sunlight.
- The repair area must be around room temperature.
- The work area must be protected from moisture.

Note

- *The vehicle can be used again immediately as soon as the repair work has been completed.*
- *Depending on the type of damage, there is a possibility that some traces of the damage will remain. However, this does not have any bearing on the success of the repair job.*
- *Once the repair is completed, the windscreen can be subjected to normal loads. The injected and hardened synthetic resin ensures that the crack will not spread any further. The hardened resin is colourless and has the same refractive index as the windscreen glass.*

14 Thread repairs

Inserts with a zinc-nickel coating must be used when repairing damaged threads.

Make sure all steel chips have been removed.

Always use genuine parts when replacing studs.

Damaged threads can be repaired using thread inserts with zinc-nickel coating.

WARNING

Only this coating ensures protection against contact corrosion.

Some threads are fitted with thread inserts at the factory.

14.1 Thread repairs for safety-related components

Depending on the design-related features of the specific vehicle, repair work on threads (such as axle mountings or seat belt mountings) may either be permissible or not possible.

Note

It is essential to refer to the Workshop Manual for the relevant vehicle in such cases.